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(54) **FORENSIC AUTHENTICATION IN ELECTRONIC WORKFLOWS**

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(51) **Int. Cl.**

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G06Q 10/10	(2012.01)
G06Q 10/06	(2012.01)
G06Q 10/08	(2012.01)
G06Q 50/18	(2012.01)
G06Q 50/22	(2012.01)

(52) **U.S. Cl.**
CPC ***G06F 9/44*** (2013.01); ***G06Q 10/06*** (2013.01); ***G06Q 10/08*** (2013.01); ***G06Q 10/10*** (2013.01); ***G06Q 50/18*** (2013.01); ***G06Q 50/22*** (2013.01)

(58) **Field of Classification Search**
CPC G06Q 50/18; G06Q 50/22; G06Q 10/08; G06Q 10/10; G06Q 10/06; G06F 9/44
See application file for complete search history.

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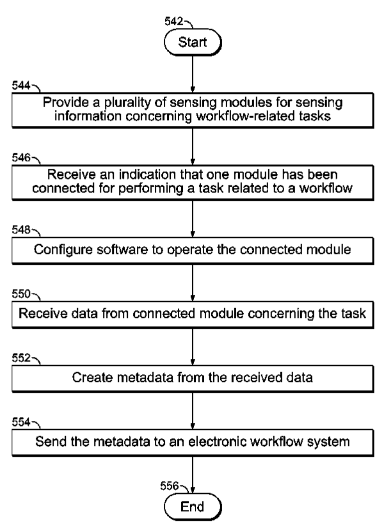
(74) *Attorney, Agent, or Firm* — Pearl, Cohen

(57) **ABSTRACT**

A system for performing task execution in a workflow includes a processor device, at least one modular device having a digital microscope that is interchangeably coupled to the processor device, a memory device coupled to the processor device comprising instructions that when executed by the processor device execute a software service, a network interface, and an electronic workflow system coupled to the processor device via the network interface. The digital microscope corresponds to at least one particular task of a workflow to authenticate a workflow item using discrepancy detection, and the software service controls operation of the at least one modular device and generates forensic metadata from task information received by the digital microscope of the at least one modular device for the electronic workflow system.

17 Claims, 16 Drawing Sheets



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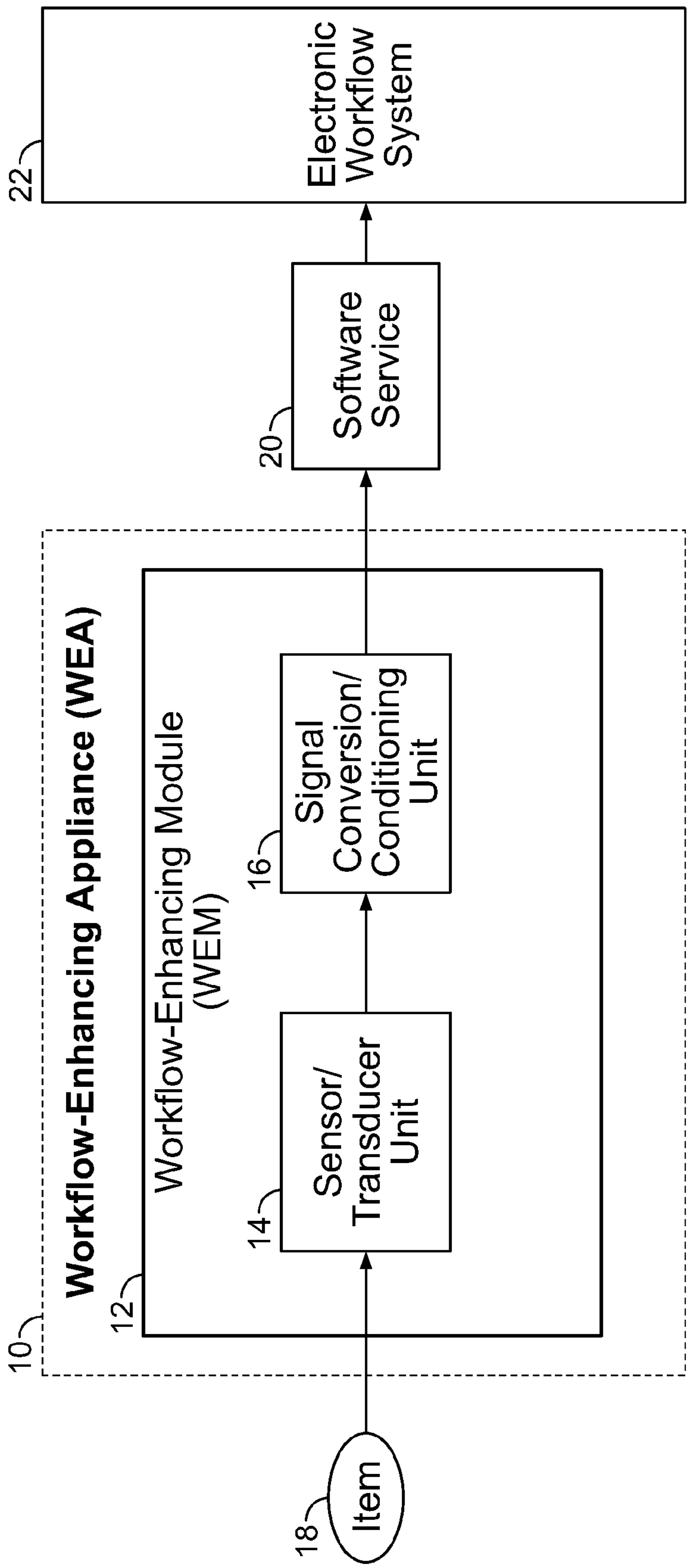

22
Electronic Workflow System
20
Software Service
10
Workflow-Enhancing Appliance (WEA)
12
Workflow-Enhancing Module (WEM)
16
Signal Conversion/ Conditioning Unit
14
Sensor/ Transducer Unit
18
Item

FIG. 1

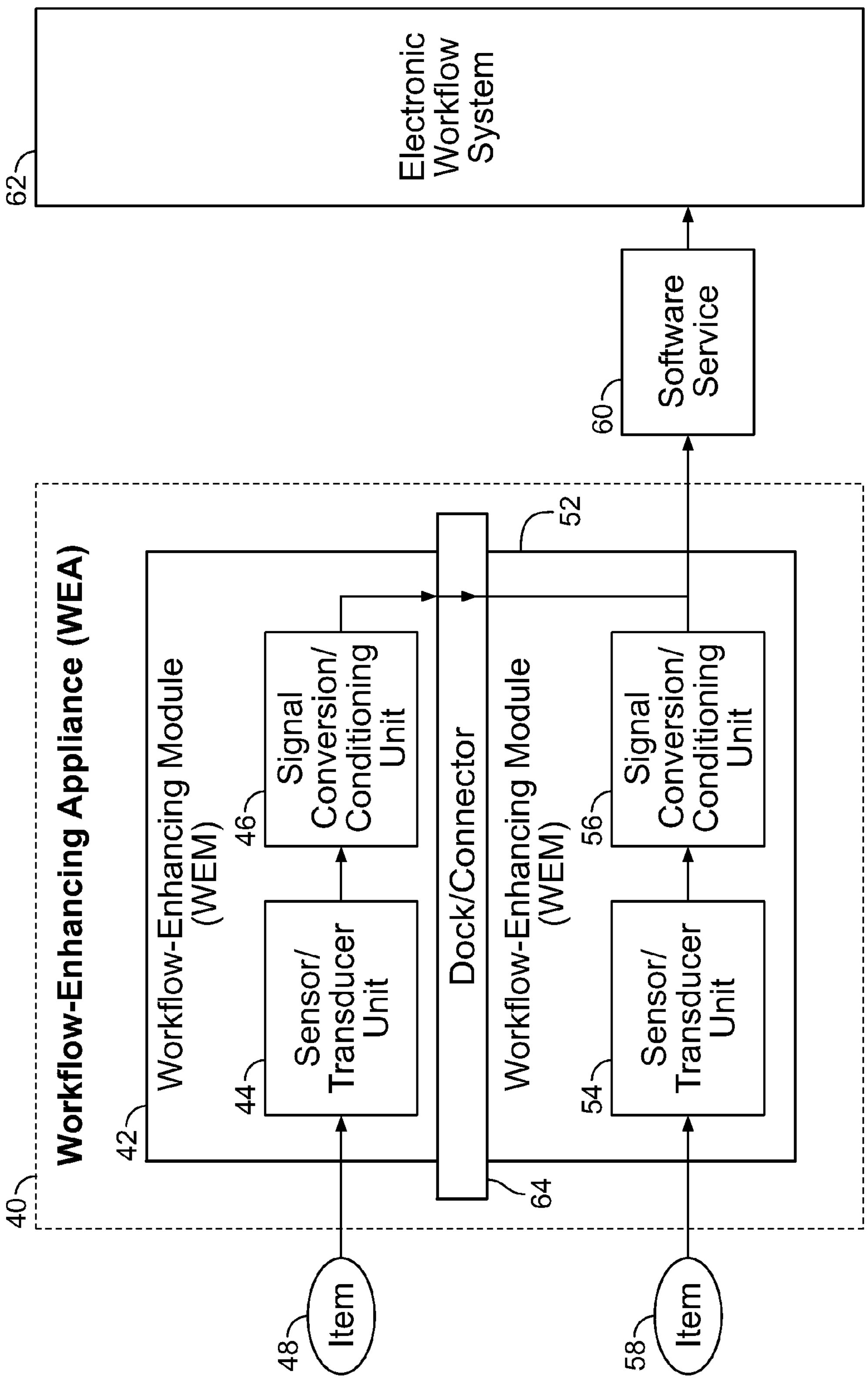
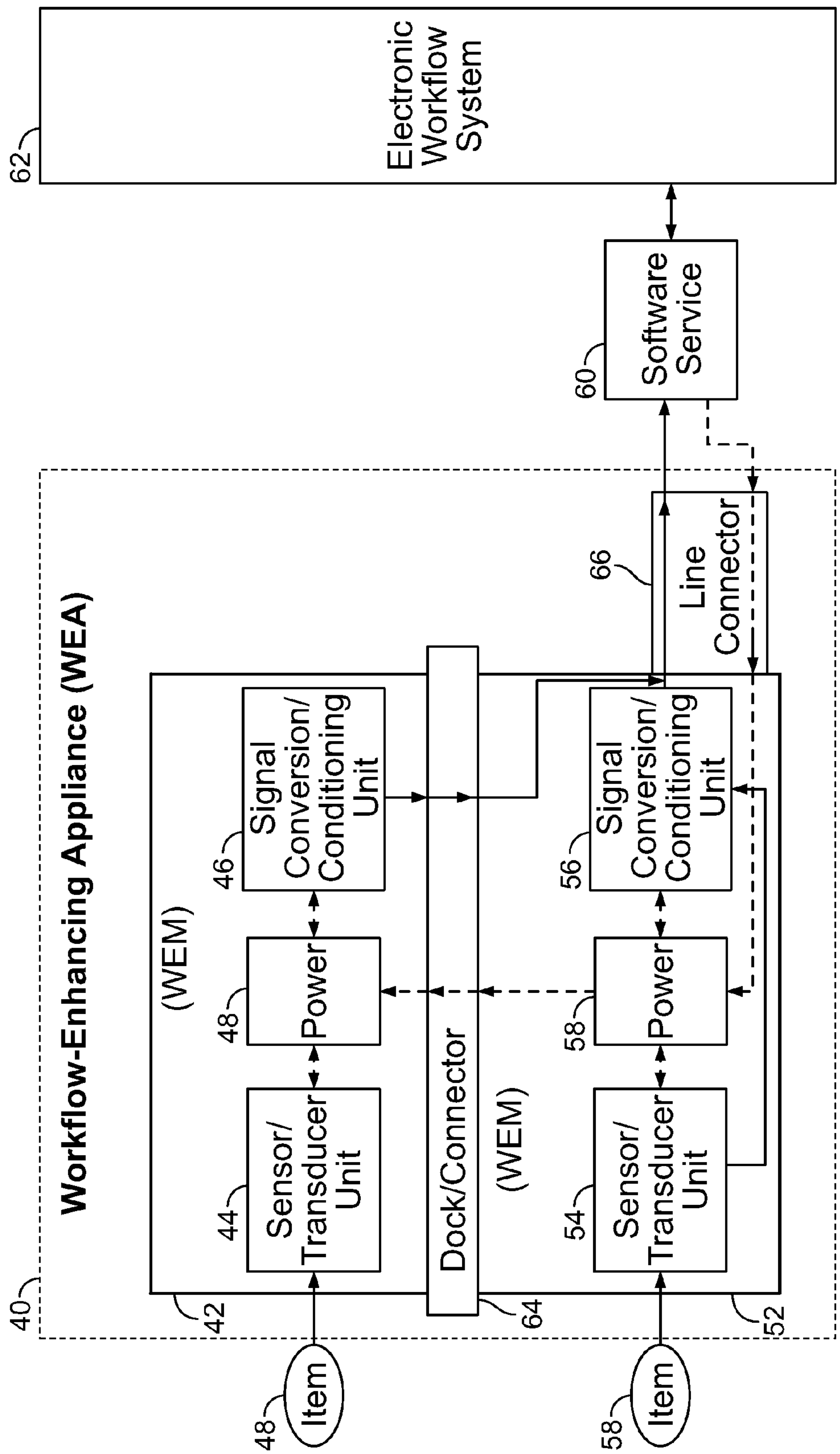

Workflow-Enhancing Appliance (WEA)
40
42
Workflow-Enhancing Module (WEM)
44
Sensor/ Transducer Unit
46
Signal Conversion/ Conditioning Unit
Dock/Connector
64
52
Workflow-Enhancing Module (WEM)
54
Sensor/ Transducer Unit
56
Signal Conversion/ Conditioning Unit
48
Item
58
Item
60
Software Service
62
Electronic Workflow System

FIG. 2A



Workflow-Enhancing Appliance (WEA)
40
42
(WEM)
44
Sensor/
Transducer
Unit
48
Power
46
Signal
Conversion/
Conditioning
Unit
Dock/Connector
64
(WEM)
52
54
Sensor/
Transducer
Unit
58
Power
56
Signal
Conversion/
Conditioning
Unit
66
Line
Connector
60
Software
Service
62
Electronic
Workflow
System
48
Item
58
Item

FIG. 2B

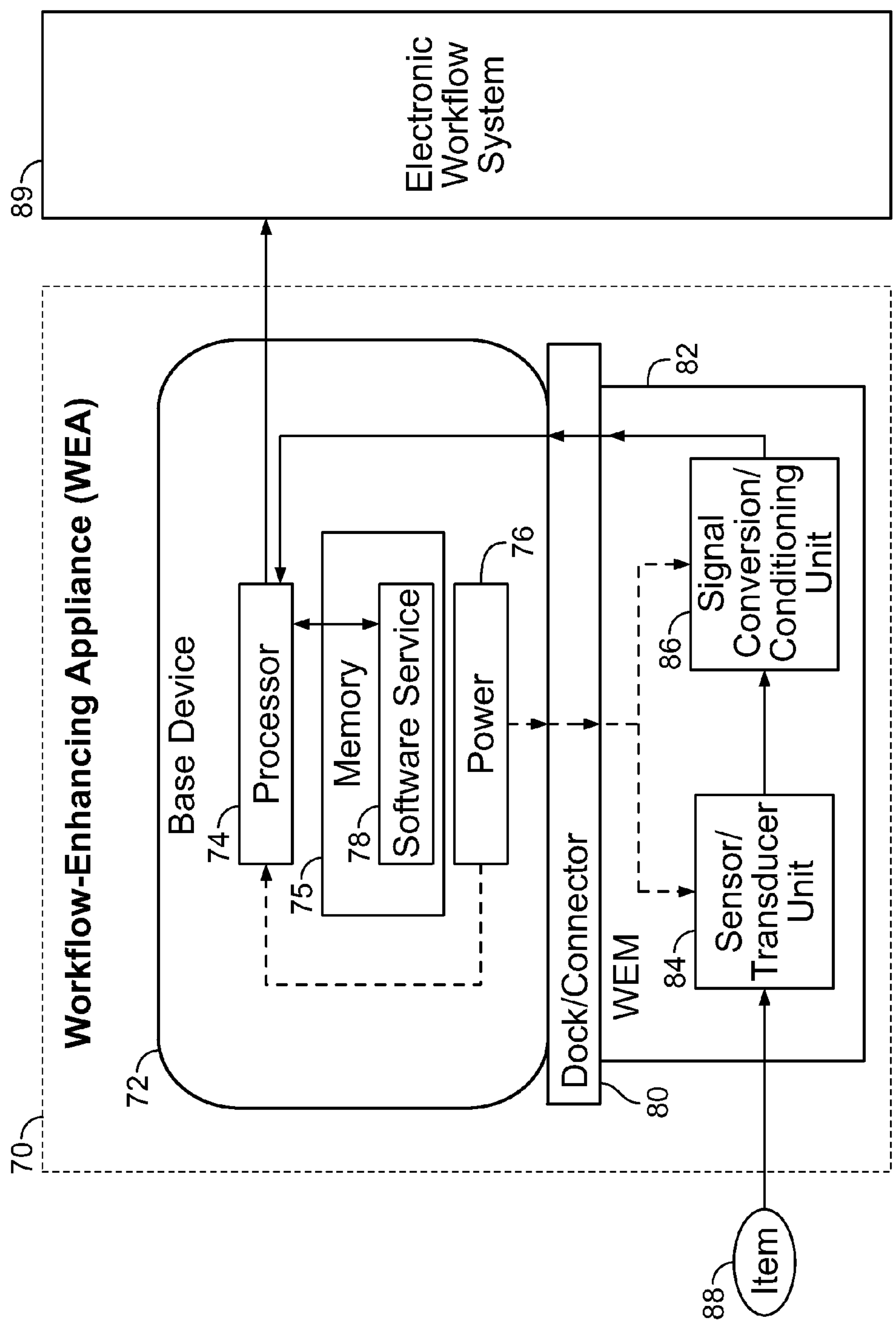

Electronic Workflow System
89
Workflow-Enhancing Appliance (WEA)
70
Base Device
72
Processor
74
Memory
75
Software Service
78
Power
76
Dock/Connector
80
WEM
82
Signal Conversion/ Conditioning Unit
86
Sensor/ Transducer Unit
84
Item
88

FIG. 3

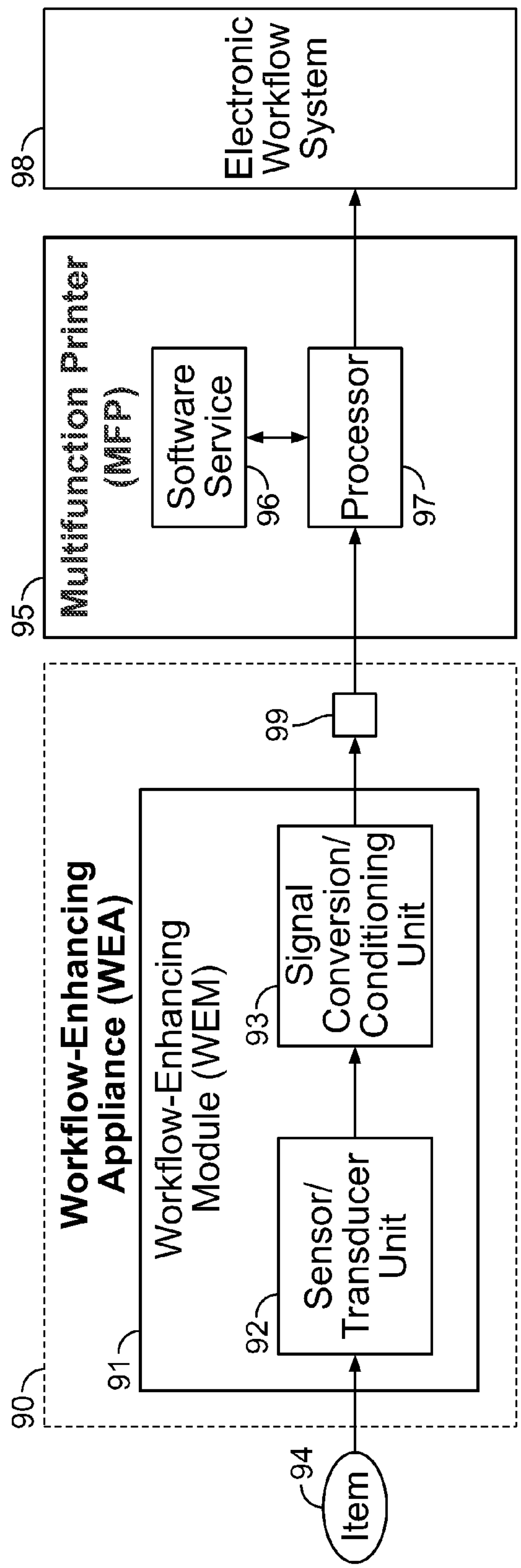

Electronic Workflow System
98
Multifunction Printer (MFP)
95
Software Service
96
Processor
97
99
Workflow-Enhancing Appliance (WEA)
90
Workflow-Enhancing Module (WEM)
91
Signal Conversion/ Conditioning Unit
93
Sensor/ Transducer Unit
92
Item
94

FIG. 4A

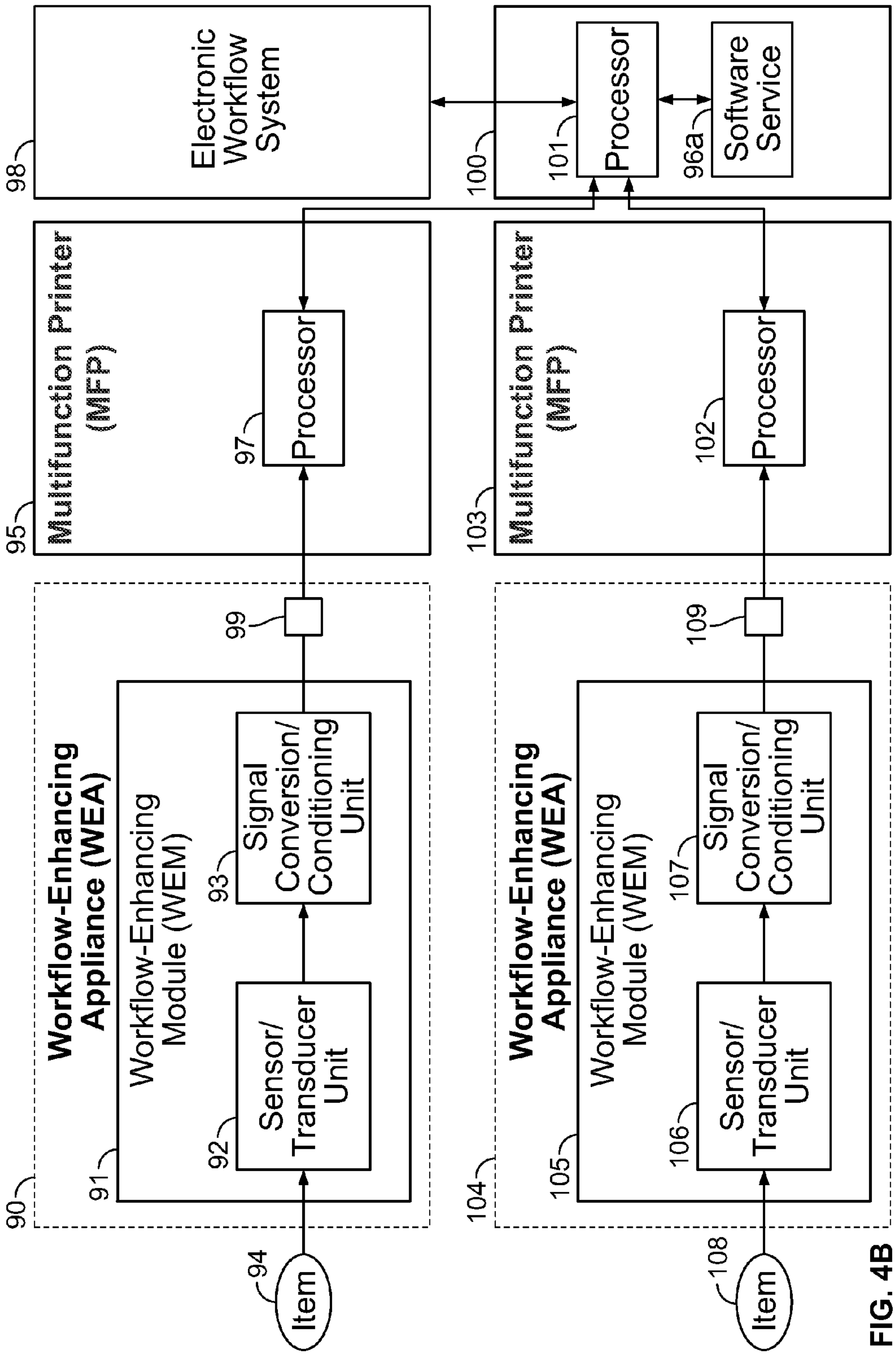

Item
94
90
Workflow-Enhancing Appliance (WEA)
91
Workflow-Enhancing Module (WEM)
92
Sensor/ Transducer Unit
93
Signal Conversion/ Conditioning Unit
99
95
Multifunction Printer (MFP)
97
Processor
98
Electronic Workflow System
100
101
Processor
96a
Software Service
Item
108
104
Workflow-Enhancing Appliance (WEA)
105
Workflow-Enhancing Module (WEM)
106
Sensor/ Transducer Unit
107
Signal Conversion/ Conditioning Unit
109
103
Multifunction Printer (MFP)
102
Processor

FIG. 4B

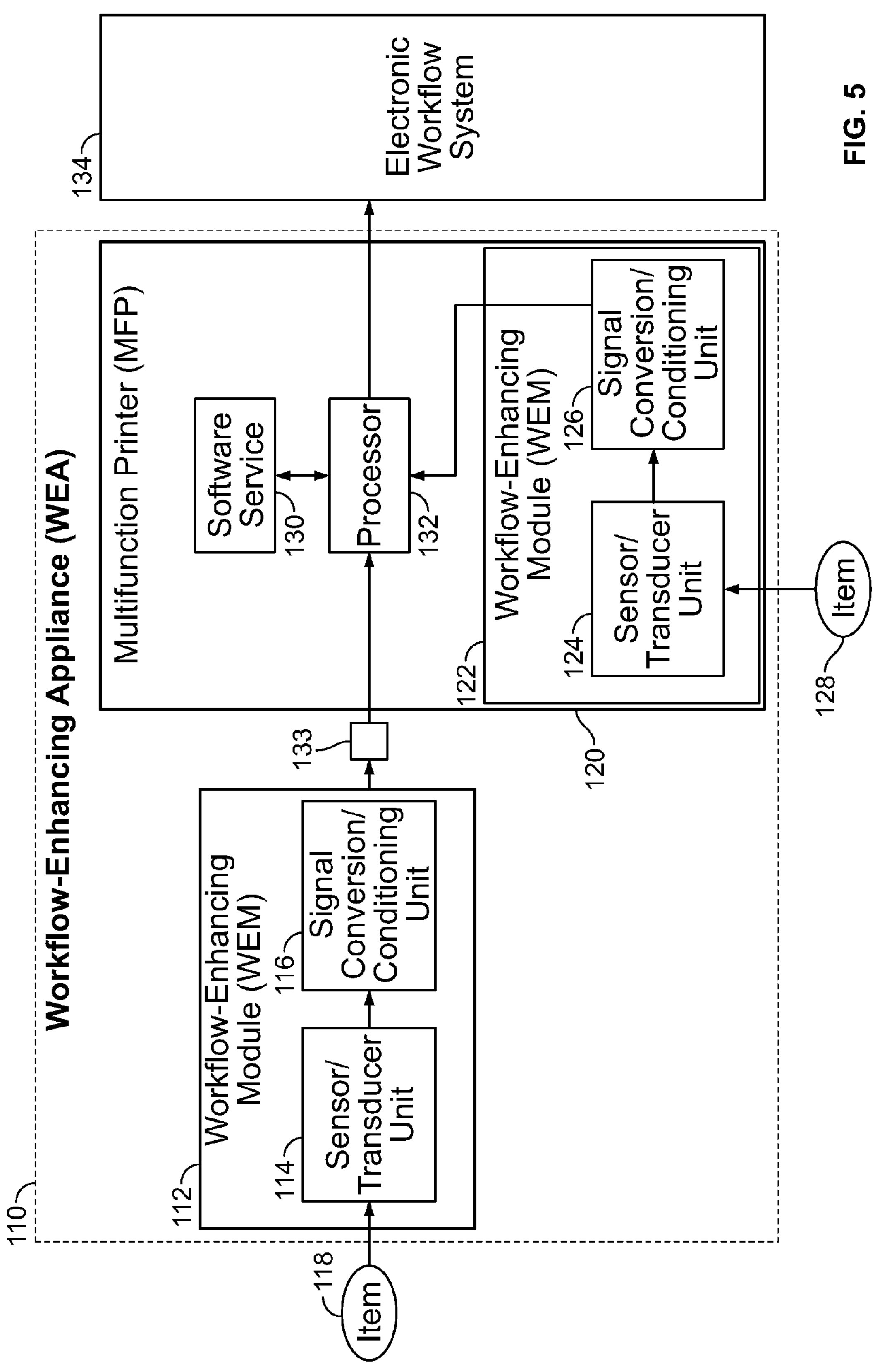

Workflow-Enhancing Appliance (WEA)
110
Workflow-Enhancing Module (WEM)
112
Sensor/ Transducer Unit
114
Signal Conversion/ Conditioning Unit
116
Item
118
133
Multifunction Printer (MFP)
Software Service
130
Processor
132
Workflow-Enhancing Module (WEM)
122
Sensor/ Transducer Unit
124
Signal Conversion/ Conditioning Unit
126
120
Item
128
Electronic Workflow System
134

FIG. 5

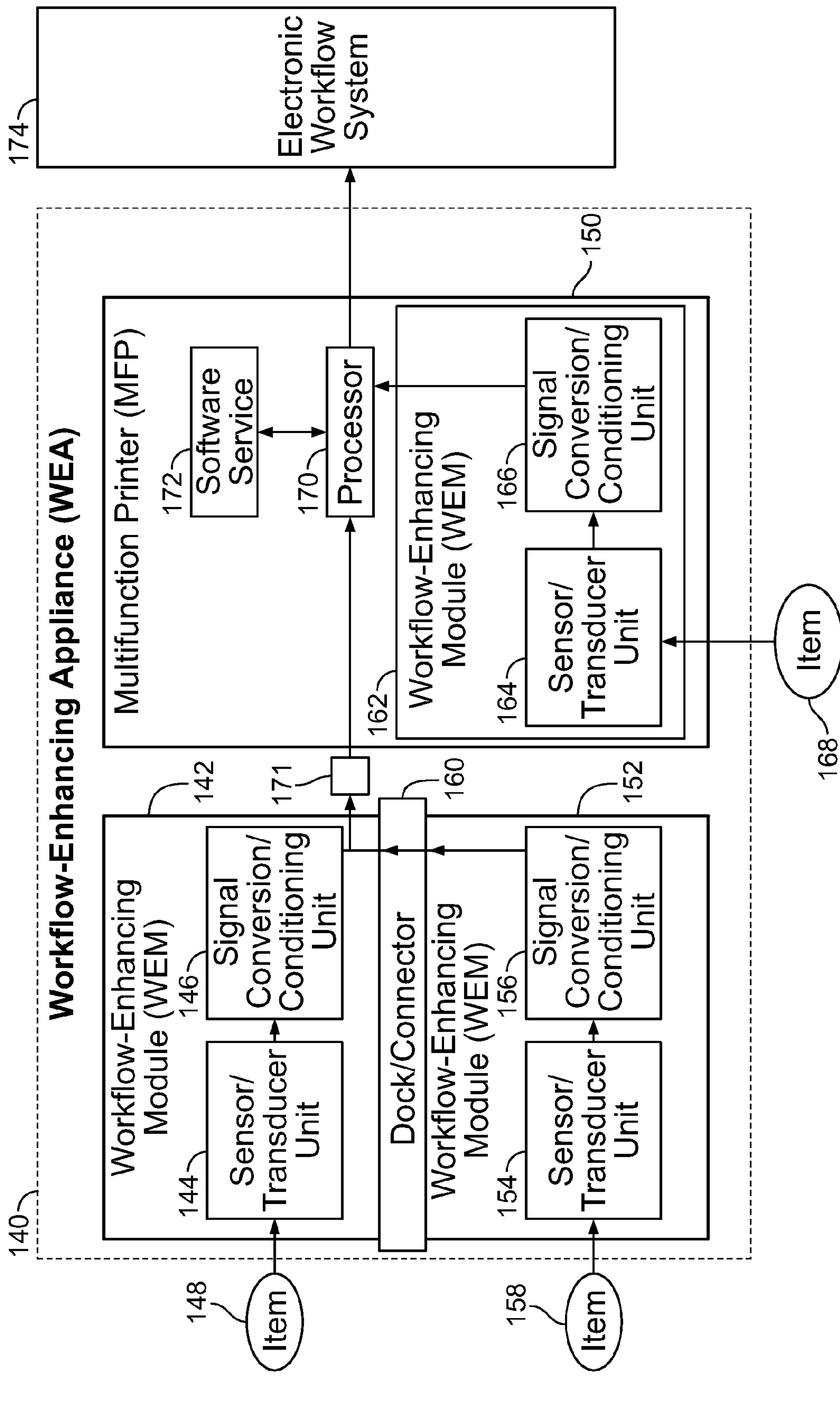

Workflow-Enhancing Appliance (WEA)
140
Electronic Workflow System
174
Multifunction Printer (MFP)
150
Software Service
172
Processor
170
Workflow-Enhancing Module (WEM)
162
Sensor/ Transducer Unit
164
Signal Conversion/ Conditioning Unit
166
Item
168
171
Dock/Connector
160
Workflow-Enhancing Module (WEM)
142
Sensor/ Transducer Unit
144
Signal Conversion/ Conditioning Unit
146
Item
148
Workflow-Enhancing Module (WEM)
152
Sensor/ Transducer Unit
154
Signal Conversion/ Conditioning Unit
156
Item
158

FIG. 6

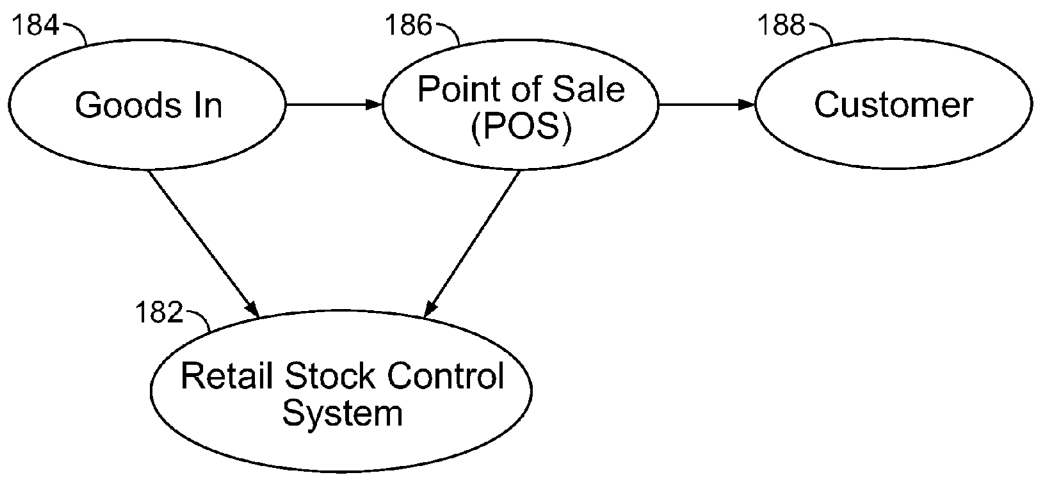


FIG. 7
(Prior Art)

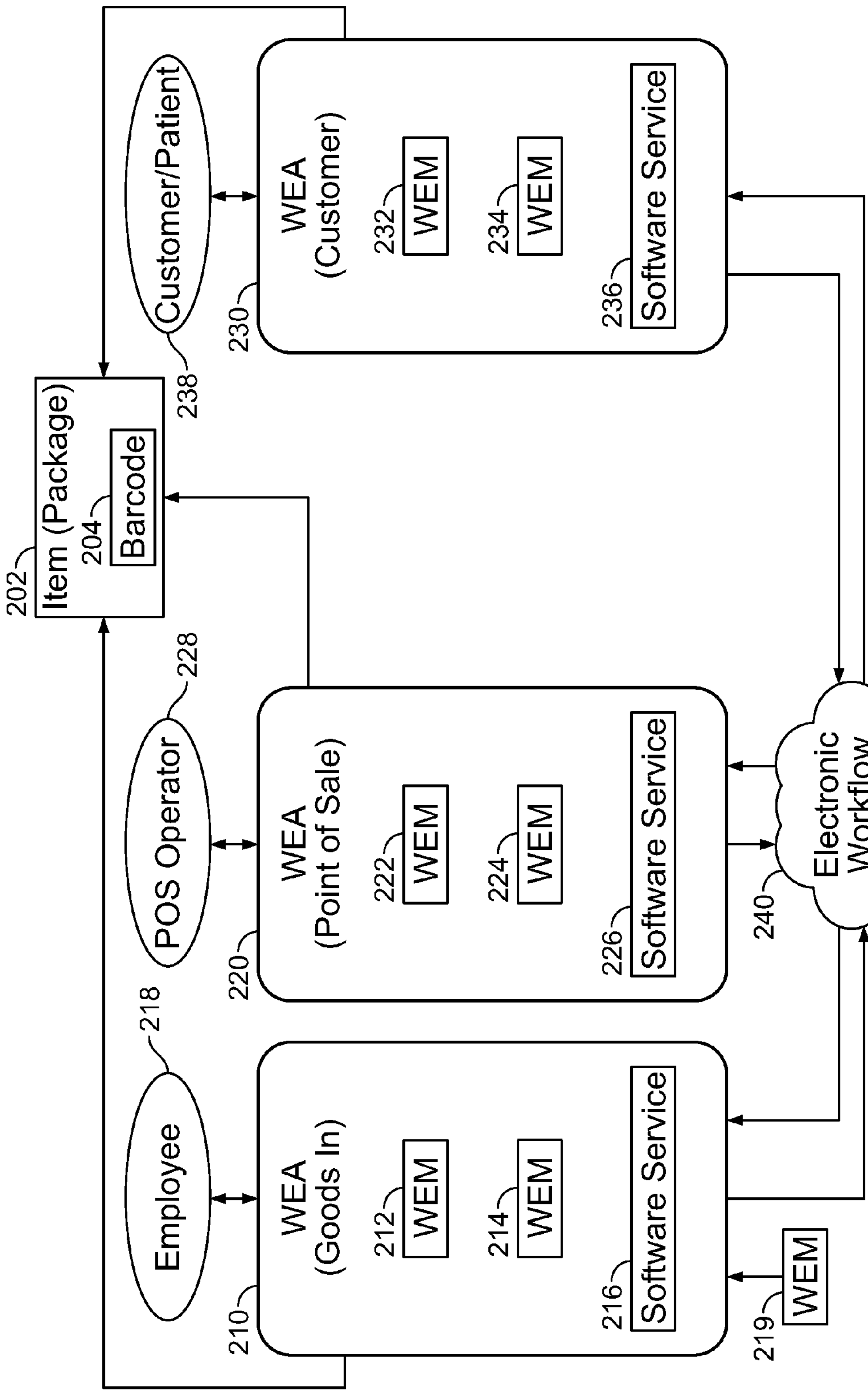

Item (Package)
202
Barcode
204
Customer/Patient
238
WEA
(Customer)
230
WEM
232
WEM
234
Software Service
236
POS Operator
228
WEA
(Point of Sale)
220
WEM
222
WEM
224
Software Service
226
Employee
218
WEA
(Goods In)
210
WEM
212
WEM
214
Software Service
216
WEM
219
Electronic
Workflow
System
240

FIG. 8

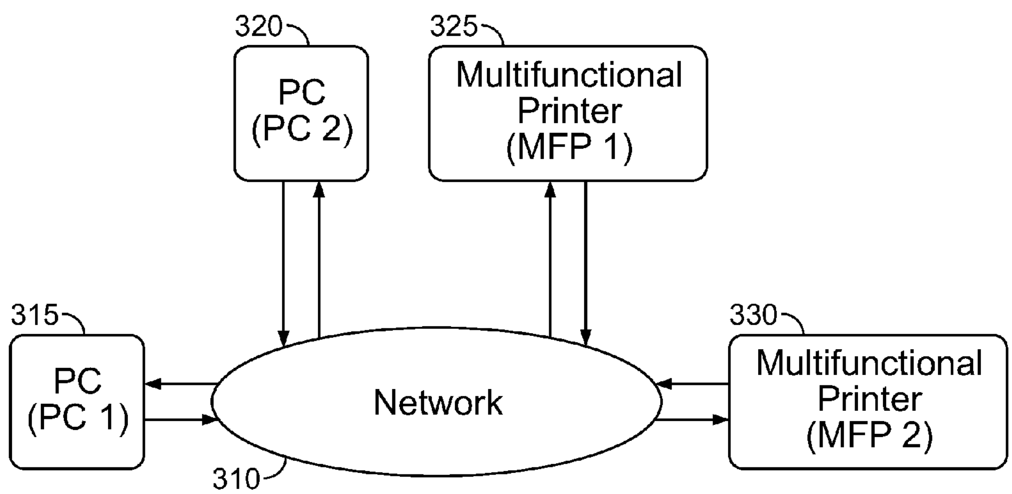


FIG. 9
(Prior Art)

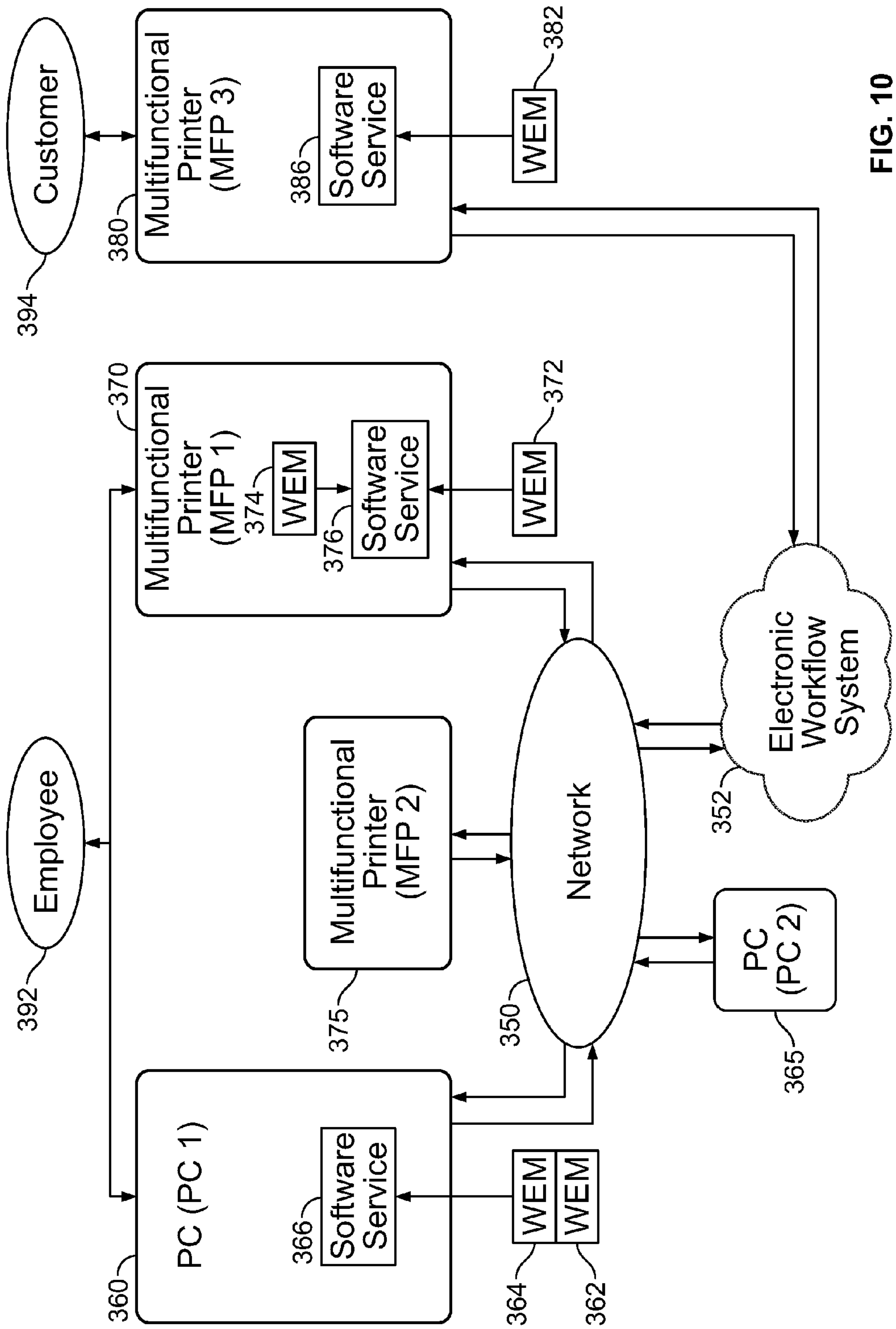

Customer
394
Multifunctional Printer (MFP 3)
380
Software Service
386
WEM
382
Employee
392
Multifunctional Printer (MFP 1)
370
WEM
374
Software Service
376
WEM
372
Multifunctional Printer (MFP 2)
375
Network
350
Electronic Workflow System
352
PC (PC 2)
365
PC (PC 1)
360
Software Service
366
WEM
WEM
364
362

FIG. 10

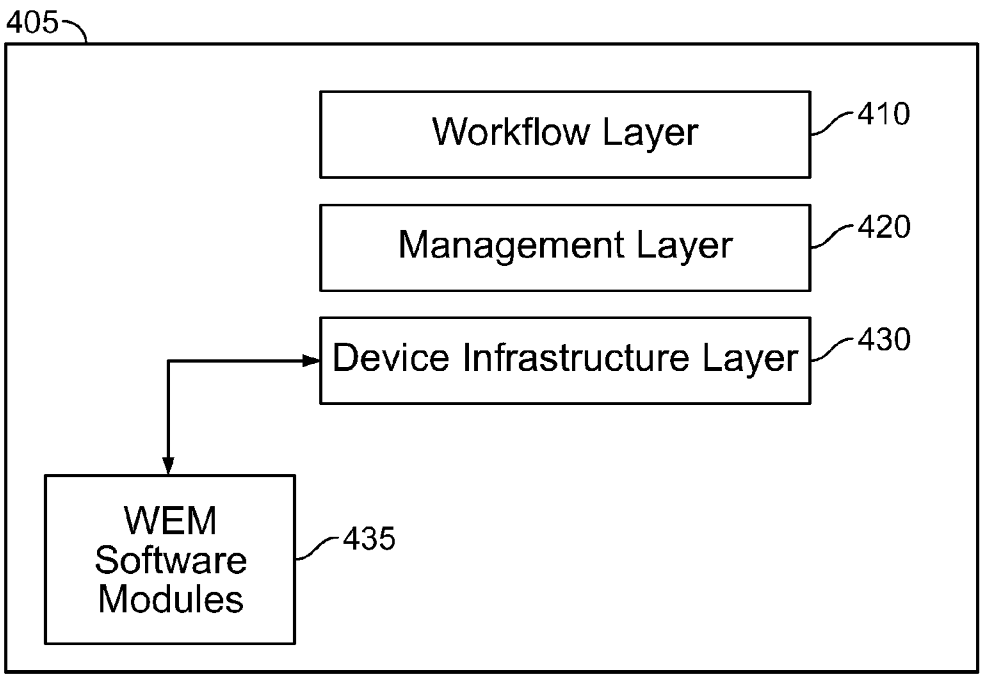

405
Workflow Layer
410
Management Layer
420
Device Infrastructure Layer
430
WEM Software Modules
435

FIG. 11

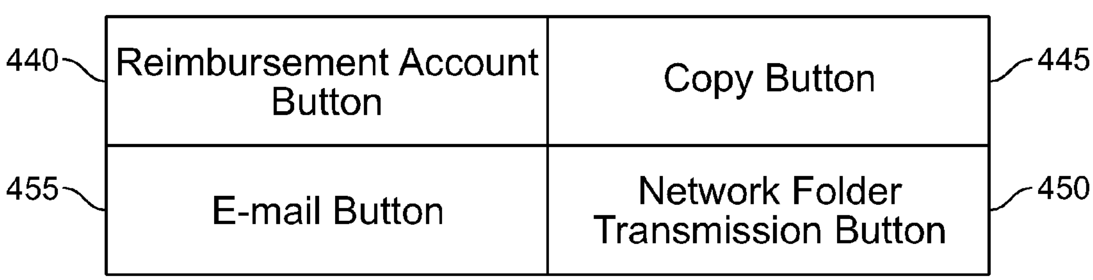

440
Reimbursement Account Button
Copy Button
445
455
E-mail Button
Network Folder Transmission Button
450

FIG. 12

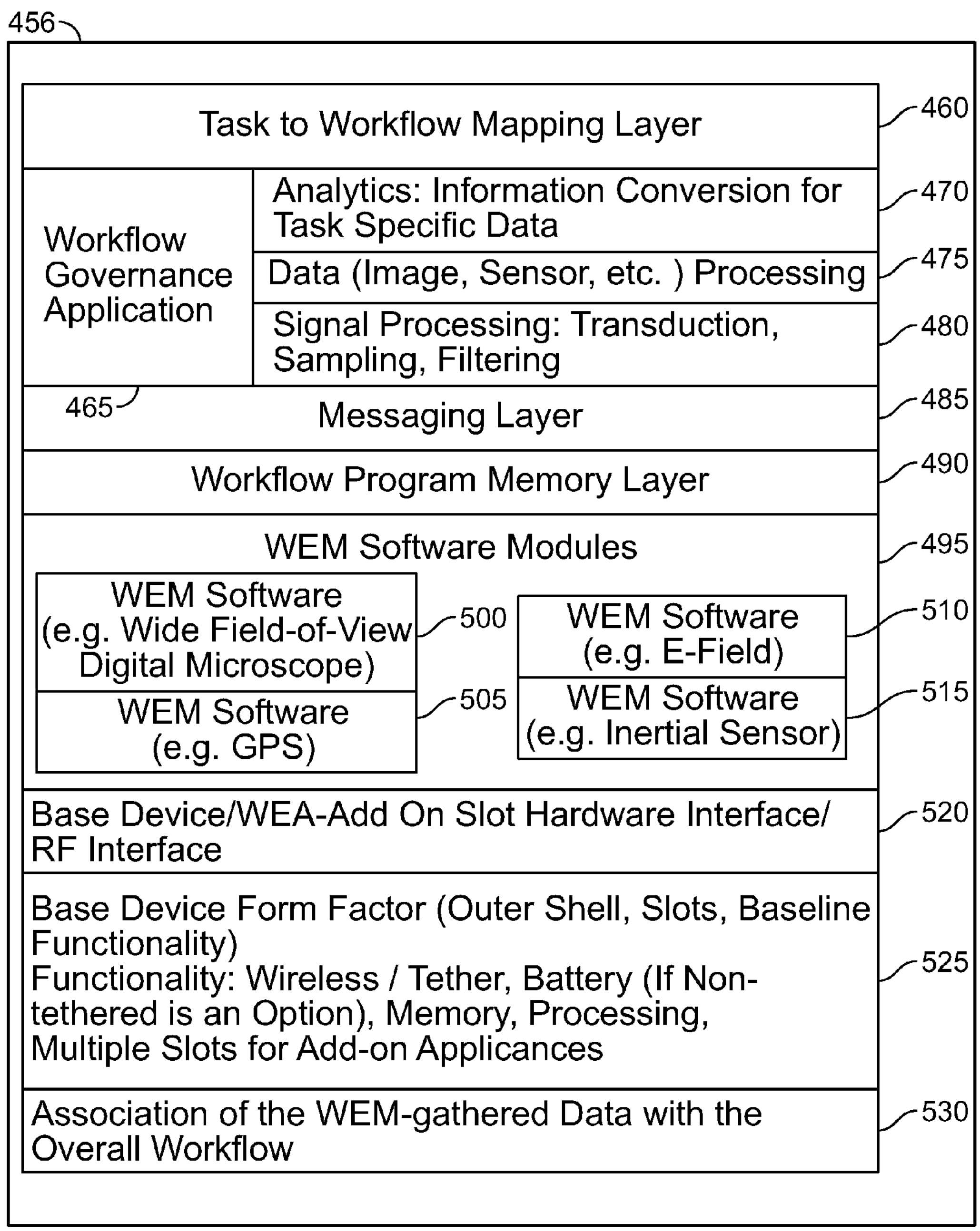

456
Task to Workflow Mapping Layer
460
Workflow Governance Application
Analytics: Information Conversion for Task Specific Data
470
Data (Image, Sensor, etc.) Processing
475
Signal Processing: Transduction, Sampling, Filtering
480
465
Messaging Layer
485
Workflow Program Memory Layer
490
WEM Software Modules
495
WEM Software (e.g. Wide Field-of-View Digital Microscope)
500
WEM Software (e.g. E-Field)
510
WEM Software (e.g. GPS)
505
WEM Software (e.g. Inertial Sensor)
515
Base Device/WEA-Add On Slot Hardware Interface/ RF Interface
520
Base Device Form Factor (Outer Shell, Slots, Baseline Functionality)
Functionality: Wireless / Tether, Battery (If Non-tethered is an Option), Memory, Processing, Multiple Slots for Add-on Applicances
525
Association of the WEM-gathered Data with the Overall Workflow
530

FIG. 13

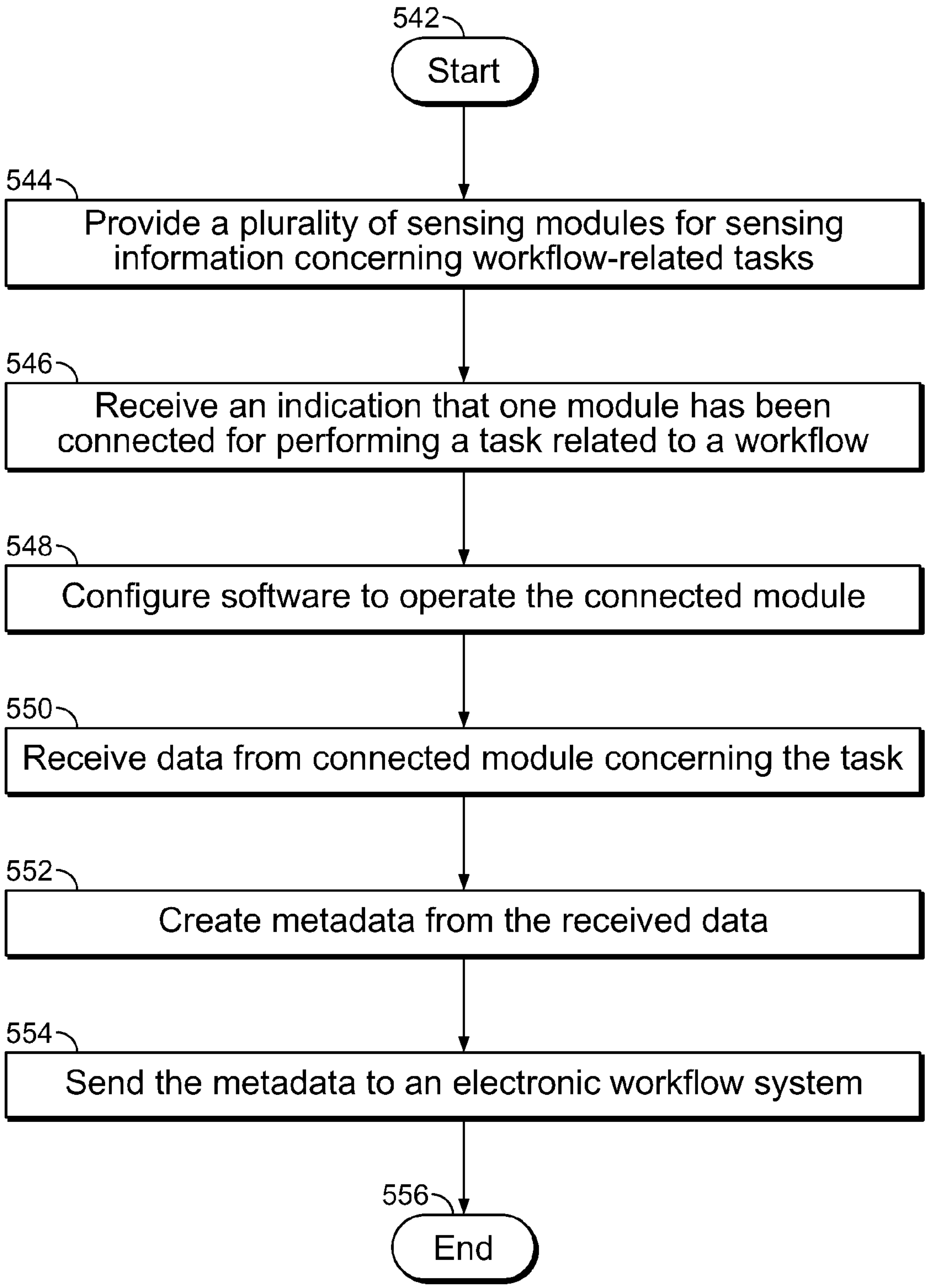

542
Start
544
Provide a plurality of sensing modules for sensing information concerning workflow-related tasks
546
Receive an indication that one module has been connected for performing a task related to a workflow
548
Configure software to operate the connected module
550
Receive data from connected module concerning the task
552
Create metadata from the received data
554
Send the metadata to an electronic workflow system
556
End

FIG. 14

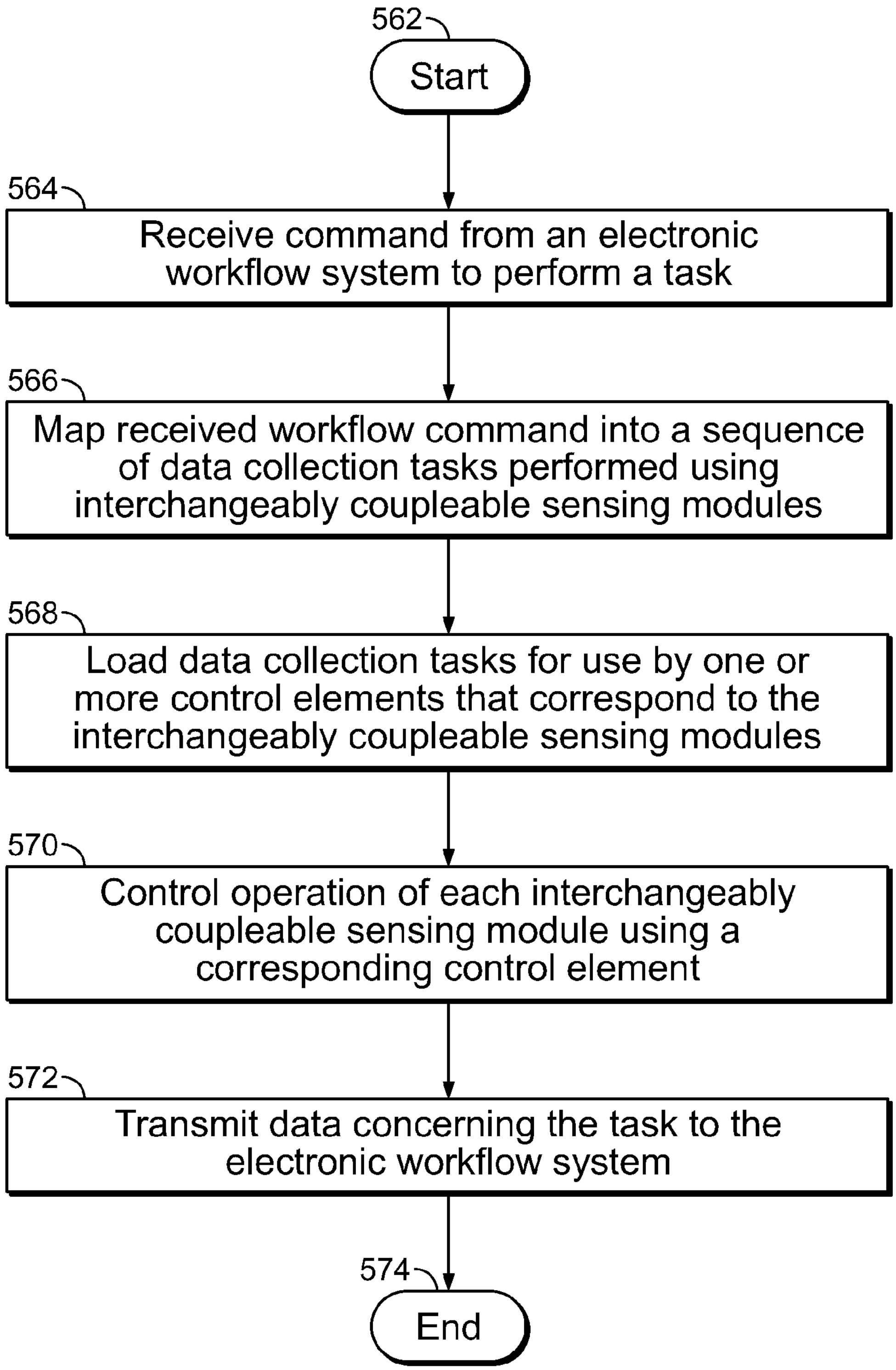

562
Start
564
Receive command from an electronic workflow system to perform a task
566
Map received workflow command into a sequence of data collection tasks performed using interchangeably coupleable sensing modules
568
Load data collection tasks for use by one or more control elements that correspond to the interchangeably coupleable sensing modules
570
Control operation of each interchangeably coupleable sensing module using a corresponding control element
572
Transmit data concerning the task to the electronic workflow system
574
End

FIG. 15

FORENSIC AUTHENTICATION IN ELECTRONIC WORKFLOWS

BACKGROUND

Documents and other printed materials may be incorporated into workflows for monitoring, tracking, data gathering etc. A workflow may include a sequence of connected steps and may provide a depiction for a sequence of operations, which may be declared as the "work" or task(s) of a person, a group of persons, an organization, and/or some other functional mechanism.

A workflow may be seen as an abstraction of real work. From the point of view of task management, a workflow may provide a view or glimpse of real work that is occurring or may occur. A workflow may serve also as a virtual representation of actual work. The flow or movement being described in a workflow may refer to a document or printed material (such as a label attached to a product) that is being transferred from one step to another.

Workflow use may be increasing, in part because of factors such as increased use of mobile imaging to connect physical items (like labels and other documents) to electronic (computerized) back-end processes. Additionally, as more tasks incorporate computerized monitoring or tracking features (or become in general more digital/electronic), and as features such as cloud services (Web-based computing resources) become more available to enable collaborative workflows (which may have been previously impractical), the rate of workflow use may further increase. Such an Increase may cause a continually larger percentage of printed material to be intentionally linked in workflows to provide electronic content (e.g. tracking or monitoring data) that may be "on-line" and available in real time.

Labels, packaging, documents, tickets and many other printed items may serve as tokens in electronic workflows. Labels, for example, increasingly "carry" (or are linked to) point-of-sale, consumer/brand interaction, "track and trace" (e.g. logistics for determining current and past locations of property), "ePedigree" (e.g. electronic chain-of-custody), authentication, and/or forensic information that can be examined or "interrogated" by a manufacturer, distributor, retailer, consumer, and/or investigative agent, as part of their interaction with the physical world.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates a workflow-enhancing appliance in accordance with an embodiment of the invention;

FIG. **2**A illustrates a workflow-enhancing appliance in accordance with an embodiment of the invention;

FIG. **2**B illustrates multiple workflow-enhancing modules in accordance with an embodiment of the invention;

FIG. **3** illustrates a workflow-enhancing appliance in accordance with an embodiment of the invention;

FIG. **4**A illustrates a workflow kiosk in accordance with an embodiment of the invention;

FIG. **4**B illustrates workflow kiosks being controlled by a centralized-control server, according to an embodiment of the invention;

FIG. **5** illustrates a workflow kiosk in accordance with an embodiment of the invention;

FIG. **6** illustrates a workflow kiosk in accordance with an embodiment of the invention;

FIG. **7** illustrates a prior art retail workflow system;

FIG. **8** illustrates a retail workflow system in accordance with an embodiment of the invention;

FIG. **9** illustrates a prior art network printing system;

FIG. **10** illustrates a network printing system in accordance with an embodiment of the invention;

FIG. **11** illustrates a layered software platform in accordance with an embodiment of the invention;

FIG. **12** illustrates a button-based interface in accordance with an embodiment of the invention;

FIG. **13** illustrates a layered software platform in accordance with an embodiment of the invention;

FIG. **14** illustrates a process in accordance with an embodiment of the invention; and

FIG. **15** illustrates a process in accordance with an embodiment of the invention.

Where considered appropriate, reference numerals may be repeated among the drawings to indicate corresponding or analogous elements. Moreover, some of the blocks depicted in the drawings may be combined into a single function.

DETAILED DESCRIPTION

In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of different embodiments of the invention. However, it will be understood by those of ordinary skill in the art that embodiments of the present invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, and circuits have not been described in detail so as not to obscure the invention.

An embodiment of the invention may provide a modular, customizable workflow-enhancing appliance (WEA), for performing workflow-related tasks and interfacing with electronic workflows. A WEA may allow, for example, data exchange with an electronic workflow while a user accomplishes a task pertinent to the workflow. An embodiment of the invention may provide a system and method for executing a workflow, using a WEA, and a system and method for modular, customizable workflow execution.

An electronic workflow may be a computer-based system to monitor or enable a set of tasks—for example, tasks for a business, tasks for medical treatment, and/or other process tasks. The term "tasks" as used herein may be an activity or unit of work that a user performs (e.g. within a time period), or an action or unit of work performed by a computer or other machine, such as the automatic scanning of a document or the automatic taking of a temperature reading. A "task" may be also the occurrence of an event, such as the arrival of a package, the printing of a document, the end of a time period, etc. In some workflows, tasks may not be expressly mapped (or pre-scripted) by a workflow. For example, as a set of tasks in a workflow proceeds from one workflow participant to another, one task may depend upon, for example, the performance (or the result) of a task performed by a preceding workflow participant (or the result of his or her task).

An electronic workflow may be configured using a set of computer processes implemented on one or more computer processors. An electronic workflow may include a relational database system to track information, e.g. information collected by a WEA. The terms "workflow", "workflow system" and "electronic workflow system" as used herein may also mean an "electronic workflow".

A WEA may allow a user to accomplish a workflow-related task and contemporaneously (or within a time period from performance of the task) interface with an electronic workflow system (e.g. to collect data, to provide a point of security access or to perform a check point function). A WEA may be part of, or may be connected (or connectable) to, an electronic workflow system and may provide a modular, customizable junction where workflow-related tasks may be performed and task-related information can be created or accessed within the electronic workflow. The workflows contemplated may vary and may include:

- Enterprise-germane workflows (e.g. track and trace, item/user authentication, inventory/order control and supply chain data-access workflows);
- Consumer-specific workflows (e.g. remote medical/diet/exercise or other medical or physical monitoring. (Consumer-specific workflows can include consumer-specified, real-time, workflows, that can be custom-created (e.g. on the fly). In such situations, a WEA may, for example, take in data, such as consumer movements or actions, and the processor of the WEA may thereafter automatically translate the data into any required WEA-enabled actions for a workflow); and
- Reactive workflows (e.g. workflows triggered by a change in data or an event. (For example a change in a workflow may be initiated by detection of counterfeits in a region resulting in the workflow being modified to include an additional requirement for forensic authentication at the point of sale. Other events such as changes in data (product movement) as determined by GPS monitoring could also trigger reactive workflow tasks. More generally, a reactive workflow may be based on real-time analytics of the workflow and the environment in which the workflow acts.)

The WEA, in accordance with an embodiment of the invention permits workflow data to be captured at the item-level. Item-level detail provides data to uniquely identify a specific item (e.g. a specific package of a particular instance of a stock item), and provides detail to distinguish the specific package or item instance from other packages or other instances of the same stock. With item-level detail, for example, the provenance of a specific package of medication may be tracked throughout a system to ensure its safety for a patient. Other uses of item-level detail are also possible and there are many uses of item-level detail. Non-item-level detail is aggregate data, such as 100 shirts of style “xxx” where the data concerning the shirts does not allow one shirt to be distinguished from another.

A WEA may include hardware configurable for task and workflow-access functionality. A WEA may include (and be customized to perform different workflow-related tasks using) one or more workflow-enhancing modules (or WEMs). A WEM may be a plug-in hardware element (that may be interchanged with other WEMs) and may include hardware (e.g. a sensor/transducer, signal converter, signal conditioner, etc.) to provide data to an electronic workflow system through a software service.

A layered software architecture (e.g. as part of the software service) may be provided to facilitate modular use of the WEMs. Such a layered software architecture may allow configurations where multiple WEMs can be added together, “swapped out” (e.g. exchanged), updated, or replaced.

Each WEM (of a modular system) may provide a WEA with specific workflow/task functionality. Any task function that can be tied to a workflow may be enabled by a WEM. For example, a first WEM may provide a 2D barcode reading functionality which may be used for scanning barcode information and tracking a package (at an item-level) through a workflow. A second WEM may allow a WEA to operate as an authentication device for a document (e.g. to validate the genuineness of a deed or other document). A third WEM may allow a WEA to provide user identification (ID) verification functionality.

Additional WEMs may provide customizable functionality (e.g. through a system of interchangeable modules) for other workflows as well. For example, one WEM may provide wireless electrocardiogram (ECG) monitor functionality for monitoring a patents heart and transmitting that information to a workflow. Such a WEM may allow a person to monitor his or her heart function (e.g. at home) and provide that information, for example, to a workflow monitored by a hospital and an insurer. Another WEM may allow GPS position information to be included in a workflow. Such sensing may provide location information for particular items (item-level specific locations) for a track and trace workflow (e.g. for automobile or other valuable item tracking). However, the invention is not limited by the descriptions of WEMs above and many different work task functions (or points of interface between task and workflow) can be provided through a WEM.

The WEMs used by a WEA (and their form) may depend upon the type of function and interface needed in the workflow. As a WEA can be incorporated into many different types of workflows (e.g. enterprise-germane, consumer-specific, reactive), the physical configuration of a WEA may also vary.

For example, a WEA may be a single WEM, or a WEA may be a group of WEMs coupled together. A group of WEMs may be also configured as a custom, stand alone device, such as for a device specific production workflow (e.g. a car assembly production line) or specific medical monitoring (e.g. an in-hospital patient monitoring device).

A WEA, in an embodiment, may include a base device (e.g. a commercially-available processor device) that may be customizable for workflow use through one or more WEMs (e.g. WEMs in the form of hardware plug-ins). The hardware plug-in may include hardware (e.g. sensor/transducer, signal converter, signal conditioner, etc.) to perform a particular task (scanning, authenticating, etc) and to convert sensor data to digitized form (e.g. for transmitting to an electronic workflow system using a software service). For example, a computer device, such as a PC, laptop, notebook, tablet (e.g. including a TouchSmart™ device by Hewlett-Packard Company of Palo Alto Calif. or an iPad™ device by Apple, Inc. of Cupertino, Calif.)-netbook, mini- or personal digital assistant (PDA) may serve as a base device for a WEA, using hardware plug-in WEMs that may be coupled to the base device. Additionally, a consumer mobile communication device such as a cell phone or higher functioning “smartphone” (cell phone with additional computing/connectivity features), such as an iPhone™ device (by Apple, Inc.), Blackberry™ device (by Research In Motion, Inc. of Waterloo, Ontario) or Droid™ device (by Motorola, Inc. of Schaumberg, Ill.) may also serve as a base device for a WEA using hardware plug-in WEMs. Other consumer mobile computer devices, such as an iPod™ device (by Apple, Inc.) or an MP3 player, could also serve as base devices for WEAs, using hardware plug-in WEMs.

Plug-in modules such as a 2D scanner (e.g. for barcode reading), authentication devices, user ID validation devices and even more specialized modules such as one for electrocardiogram (ECG) monitoring can may all be added to a base device to enable workflow-related task and workflow interface functioning. Further, “on-board” functionality (e.g. functionality that is within or integral to the device, such as image or sound capture functionality) of computer devices and mobile communication devices may also be incorporated for workflow use by WEMs that permit communication with an electronic workflow system.

WEMs may include specialized scanning or sensing devices such as scanners, barcode readers and other authentication devices. A WEM, in an embodiment, may include a high-end sensor device, such as for example, a digital microscope, including contact digital microscopes and digital inspection microscopes that provides forensic imaging for discrepancy detection in printed material. The field-of-view of such a microscope may be adapted to be sufficiently wide to be able to capture multiple printed characters/fiducials. Such a device may be configured as a WEM plug-in.

In an embodiment, a system of WEMs for modular, customizable workflow task and interface may be applied to a workflow that incorporates network printing. In such an example, a multifunctional or "all-in-one" printer (a MFP) may be configured with one or more WEMs to make up a task-customizable "workflow kiosk." A workflow kiosk may incorporate printing and other tasks into an electronic workflow using one or more WEMs.

A workflow kiosk may also be made using a device other than a printer, such as a router, PC workstation or other processor device. A MFP with one or more WEMs may be considered a WEA (e.g. a base device (MFP)+WEM(s)). An MFP may be an office machine which incorporates the functionality of a group of previously separate and distinct devices, such as a printer, scanner, photocopier, facsimile machine and email terminal. When configured with additional WEMs, an MFP may perform additional tasks and serve as a point of interface with an electronic workflow.

An MFP, in an embodiment, may be configured with one or more WEMs internally to allow the MFP to provide user authentication and document authentication tasks. Authorization tasks (e.g. allowing a document to be printed or picked up from a printer only with authorization) may be implemented though the use of an internal WEM. In such an example, one or more WEMs may also be connected or "tethered" to a MFP, where the WEMs are external to the MFP.

A WEA (such as a single WEM, multiple WEMs, a base device and WEM(s), or a MFP workflow kiosk device) may serve as a "suite" (or re-usable group) of WEA devices. In such an example, one WEA may perform different tasks (with different WEMs) at different points of a workflow. A WEA, at one point in a workflow, for example, may provide inventory checking or location finding function (using a first WEM), while at another point in the workflow, the same device may provide a security check or authorization point (using a second WEM). A WEA may also serve as an interface point for a number of different electronic workflows using different WEMs.

WEMs may be modularly configurable to themselves or to a base hardware device. For example, WEMs may be added together to themselves or added to or removed from a base device (e.g. a consumer computer device). In such a modular environment, a single device may be used in many different ways in different workflows, individually or in combination with other devices-WEMs may be used in completing specific tasks as required by, for example a processor directing workflow tasks.

Devices contemplated include (but are not limited to) MFPs enabled with tethered/plug in/Bluetooth (open wireless technology standard) modules, generic mobile devices (e.g. computers, PDS, smartphones, cell phones, MP3 players etc.) or custom mobile platforms with expansion slots/Bluetooth modules. Specialized (custom) modules cover workflows in application domains, such as workflows in the investigative, scientific, environmental and healthcare fields (e.g. a mobile ECG application implemented through vibration-sensitive readers on handheld-effective a single lead ECG) etc.

A modular configuration of workflow-enhancing modules (WEMs) for use in workflow-enhancing appliances (WEAs) may provide advantages in use. For example, a modular system of WEMs may allow for optimized WEA device configuration, such as for example, a WEA that may be customized by task with different WEMs. Where a workflow is not fully mapped out and the interaction of an actor/agent (usually human) in the workflow may not be known a priori, a modular configuration of workflow-enhancing modules may allow the actor(s)/agent(s) to perform the different tasks that may be expected of her/them at a task stage depending on the characteristics/state of the workflow.

For example, if a document, which initially was public (or required no security) has become confidential during the workflow, security/forensics may be required that could not have been predicted by the user. In such a situation a WEA such as a workflow kiosk may request a WEA-related action by the agent based on a "real-time" decision of a workflow processor.

A modular system of WEMs may be dynamically configurable, scalable and upgradeable and may allow use of a single appliance (a single WEA) in multiple workflow tasks. Such a modular system may provide an enhancement to the workflow methodology and may provide new opportunities for workflow monitoring and workflow-related services. The modular system may further allow WEMs to be employed in different configurations such as in tethered, and stand alone (handheld/mobile) configurations.

Current device configurations for workflow devices have been formed traditionally as a function of preference, history/current event and compliance/policy needs. The currently-available approaches do not offer a unified solution that addresses the variable touch points in the evolving workflow systems, such as those utilizing item-level data.

Workflow-Enhancing Appliances

Reference is now made to FIG. **1**, which illustrates workflow-enhancing appliance (WEA) **10** having a single workflow-enhancing module (WEM) **12**, in accordance with an embodiment of the invention.

WEM **12** may gather data concerning item **18** and transmit the data to software service **20**. WEM **12** may be interchangeably coupled to a processor (or processor device) operating software service **20**. Software service **20**, in turn, may forward the data to electronic workflow system **22**. In this example, WEA **10** includes a single WEM (WEM **12**). However, in other examples WEA **10** may include more than one WEM (a plurality of WEMs) or a base device and one or more WEMs (Base device+WEM(s)). Further examples, such as a WEA that is a custom device (not made from interchangeable modules) are also possible.

WEM **12** may provide a task functionality that can be incorporated into a workflow. Any task that can provide data or can constitute a point of authorization or other checkpoint for a workflow may be represented through WEM functionality.

For enterprise-germane workflows (e.g. track and trace) WEM **12** may be configured for tasks such as validating or authenticating a document (printed matter on a document), validating or authenticating a user, obtaining certification from an inspector's review, determining product or document location, or validating other characteristics of an item.

For consumer-specific workflows (e.g. remote medical monitoring), WEM **12** may be configured to validate the ID of a user and determine his or her location, validate the authenticity of a drug or medication being taken by the user, or obtain certification of a doctor's, nurse's, or medical attendant's actions.

For reactive workflows (e.g. a pharmaceutical distribution), WEM **12** may, for example, be configured to locate and validate at a forensic level, items in the supply chain when counterfeit products are detected. As above, if a document (e.g. a legal document or document concerning a product) has been switched in a workflow to confidential (or needing high scrutiny), then an additional WEM may be required to forensically analyze a given mark in the document, to provide a biometric response, etc.

WEM **12** may include sensor/transducer unit **14**—and signal conversion/conditioning unit **16** for enabling task functionality. Sensor/transducer unit **14** may include hardware that measures a physical quantity or aspect concerning item **18**. Sensor/transducer unit **14** may measure an aspect concerning item **18** that is relevant to the particular workflow-related task. Sensor/transducer unit **14** may further include hardware that receives and responds to a signal, and may further output a signal, such as a signal representing piezo/displacement, temperature, etc.

WEM **12** may be configured, in an embodiment, to authenticate printed material. In such an example, item **18** may be printed material on a label, document or other item, like a deed, stock certificate, bill of currency or artistic print. WEM **12** may provide functionality to validate or authenticate item **18**. In such an example, sensor/transducer unit **14** may include, for example, a 2D scanner (barcode reader capable of reading a barcode or other identifier within the printed material) or sensor/transducer unit **14** may include a high-fidelity imager, such as a wide field-of-view digital microscope, including contact digital microscopes and digital inspection microscopes.

A digital microscope (e.g. that may be incorporated in sensor/transducer unit **14**) may include a catadioptric or dioptric, contact-lens based CMOS imaging hardware device capable of high-resolution image scanning at 1:1 magnification and 5 micron (or better) optical resolution, over a field-of-view that is sufficient to enable capture of printed characters and fiducial elements. Such device hardware enables high-resolution scanning and facilitates the capture of both intentional printing shapes and unintentional printing artifacts caused by the printing process and interaction of the ink with the substrate on which printing occurs. Where sensor/transducer unit **14** includes a wide field-of-view digital microscope device, it may be possible to authenticate a document based on the printing of the document itself, rather than requiring the document to include a bar code or other uniquely identifying label.

In another embodiment, the workflow-related task may be to provide user identification. Item **18** in such an example may be a body part of a person, and the workflow-related task may be to provide user identification (e.g. to certify pick-up, delivery, or quality-control inspection of a document or product). For this example, sensor/transducer unit **14** may include hardware for user identification (ID) validation, such as a fingerprint scanner, retinal scanner, voice processing hardware or inertial sensing device (e.g. for gathering handwritten signature biometrics). For user ID validation, an alternative embodiment may provide functionality to inspect a card, badge or other device carried by a user for identification. In such an embodiment, item **18** may be a card, badge or other user-carried device (e.g. a "Smart card" (card with integrated circuits)) and sensor/transducer unit **14** may include a reader, such as a magnetic strip reader or Smart card reader.

Signals from a sensor within sensor/transducer unit **14** may be received by a transducer, which may convert the form of the received signal—e.g. piezo/displacement, temperature, etc., into for example an analog (or alternatively a digital) electrical signal. Signal conversion/conditioning unit **16** may receive the signal output of sensor/transducer unit **14** (for example as an analog signal) and prepare a digital output signal from the received input, such as by performing an analog-to-digital conversion (ADC). Conditioning can be, for example, filtering, which may be analog or digital filtering (done before or after conversion) depending on the application, etc. (e.g. analog conditioning may be done to amplify a signal before the signal conversion. After digital conversion, filtering may be done, for example, to smooth a sampled digitized signal)

Signal conversion/conditioning unit **16** may provide digital output to software service **20**. Software service **20** may provide an interface to electronic workflow system **22**. Software service **20**, for example, may receive data from signal conversion/conditioning unit **16** and may format or otherwise operate on the data, for example, to create usable metadata for electronic workflow system **22**. In such an example, the metadata created may be unique to item **18** (e.g. in the form of either document authentication information or user ID information) and hence the data is provided at item-level and specific to the workflow related task. Moreover, this data may be used for downstream authentication—for example in a situation where a reactive workflow requires a capture of forensic information because there has been a change in the workflow—(such as to provide the ability to send a document to a previously disallowed party, etc.) Electronic workflow system **22** may be configured to process metadata received on an item-level as well.

The connection between WEM **12** and software service **20**, may be a physical connection, e.g. through a wire (such as through a Universal Serial Bus (USB), FireWire (IEEE 1394 interface), local area network (LAN) or other line-based connection). In an alternative embodiment, the connection between WEM **12** and software service **20** may be through a wireless connection, such as Bluetooth or "Wi-Fi" (Wi-Fi Alliance supported connectivity technology). Any kind of known communication medium may be used. As such, signal conversion/conditioning unit **16** may be configured to output data to software service **20** following the protocol for the communication medium, e.g. 100BaseT (Fast Ethernet standards for twisted cable pairs).

Power for sensor/transducer unit **14** and signal conversion/conditioning unit **16** may be provided by a power source within WEM **12** (not shown). Where the connection between WEM **12** and software service **20** is a connection such as USB or FireWire, power may be supplied by the connection. Sensor/transducer unit **14** may include individual sensor and transducer components or the sensor and transducer components may be combined into units such as a sensor/transducer unit. Signal conversion/conditioning unit **16** may also include separate signal conversion and signal conditioning units. Other configurations of sensor(s), transducer(s), signal converter(s) and signal conditioner(s) in individual and/or combined units are also possible.

Reference is now made to FIG. **2**A, which illustrates a workflow-enhancing appliance (WEA) having multiple workflow-enhancing modules (WEMs), in accordance with an embodiment of the invention.

FIG. **2**A depicts a configuration where WEA **40** transmits data to software service **60**, and software service **60** (in turn) forwards metadata to electronic workflow system **62**. The configuration is similar to the configuration in FIG. **1**, however, WEA **40** in FIG. **2**A includes two WEMs: WEMs **42** and **52**. WEM **42** may include sensor/transducer unit **44** (a unit like sensor/transducer unit **14** above) and signal conversion/conditioning unit **46** (a unit like signal conversion/conditioning unit **16** above). Similar to WEM **42**, WEM **52** includes sensor/transducer unit **54** and signal conversion/conditioning unit **56**. WEM **42** and **52** may be interchangeably coupled together by dock/connector **64**.

WEMs **42** and **52** may provide functionality for different tasks that may be incorporated into a workflow. WEMs **42** and **52** may, for example, provide data or create a point of authorization or other checkpoint for a workflow. Each of WEMs **42** and **52** may provide one of the functions described above for enterprise-germane, consumer-specific or reactive workflows. Dock/connector **64** may be a suitable multi-way connector. For enabling the task functionality, WEM **42** and **52** may include sensor/transducer units **44**, **54** and signal conditioner/converter units **46**, **56**, respectively.

Sensor/transducer unit **44** may measure a physical quantity or aspect concerning item **48** and sensor/transducer unit **54** may measure a physical quantity or aspect concerning item **58**. Sensor/transducer units **44**, **54** each may convert their respective measurements into signals. Output from sensor/transducer units **44**, **54**, respectively, may be in the form of analog signals, for example. Signal conversion/conditioning units **46**, **56** each may receive analog outputs from sensor/transducer units **44**, **54**, respectively, and may provide digital output to software service **60**. Software service **60** may be operated by a processor (not shown) and WEM **52** may be interchangeably coupled (e.g. through connector **61**) to the processor (and thereby may have a link to software service **60**).

FIG. **2**A shows signal conversion/conditioning unit **56** directly outputting to software service **60**, while signal conversion/conditioning unit **46** may output to software service **60** through dock/connector **64**. However, the example is not limited in this manner and other configurations are also possible, such as where each of signal conversion/conditioning units **46** and **56** output directly to software service or signal conversion/conditioning unit **56** outputs through dock/connector **64**.

In one example, WEM **42** may be configured to authenticate printed material, such as printed material on a label or printed material on a document or other item, like a deed, stock certificate, bill of currency or artistic print. In such an example, item **48** may be printed material, and sensor/transducer unit **44** may include, for example, a 2D scanner or sensor/transducer unit **44** may include a wide field-of-view digital microscope device (described also above), which provides forensic image analysis capability.

In such an example, WEM **52** may validate user identity. Item **58** may be a body part of a person, and sensor/transducer unit **54** may include hardware for providing user identification validation, such as a fingerprint scanner, retinal scanner, voice processing hardware or inertial sensing hardware. (In another example, item **58** may be a card or ID badge carried by a person, and sensor/transducer unit **54** may include a reader, such as a magnetic strip reader or Smart card reader.)

Power for units **44**/**46** and units **54**/**56** in WEMs **42**, **52**, respectively, may be provided by a power source (not shown) within each of WEMs **42** and **52**. For example each of WEMs **42** and **52** may have separate power sources maintained separately and not shared between dock/connector **64**. Where the connection between WEA **40** (comprising WEMs **42**, **52**) and software service **60** is a physical connection, such as USB, FireWire or other wire-based connection (where power is supplied), power may be supplied to WEAs **42**, **52** by the connection.

Reference is now made to FIG. **2**B, which illustrates WEMs **42**, **52** receiving power through a line connection, in accordance with an embodiment of the invention. FIG. **2**B, depicts WEA **40** again with same configuration of WEMs **42**, **52** shown in FIG. **2**A. Each of WEM **42**, **52** (using sensor/transducer units **44**, **54** and signal conversion/conditioning units **46**, **56** respectively), gathers measurements concerning items **48**, **58**, respectively, and transmits that information (in digitized form) to software service **60** (which in turn creates metadata and transmits the metadata to electronic workflow system **62**).

In FIG. **2**B, software service **60** may be a computer system comprising, for example, a processor, computer programming (in a memory) and a power source. WEA **40** may be interchangeably coupled to software service **60** by a line connection, such as a USB, FireWire, Power over Ethernet (PoE) (e.g. IEEE 802.3af-2003 or IEEE 802.3at-2009 standards) or other wire connection that supplies power. In this example, line connector **66**, which in this case is part of WEM **52**, may provide a location for the line connection to occur between WEA **40** and software service **60**. Line connector **66** may be an RJ45 registered jack if it is an Ethernet connection. Alternatively, WEA **40** may be interchangeably coupled to software service **60** by a wireless connection (e.g. Bluetooth or WiFi).

In an embodiment with a line connection, the line connection may include multiple individual lines for power and data transfers. In FIG. **2**B a dotted line shows a power line transfer from software service **60** to power connection point **58** in WEM **52**. Power may then flow from power connection point **58** to sensor/transducer unit **54** and signal conversion/conditioning unit **56**, and, further into WEM **42** through dock/connector **64**. In WEM **42** power may flow from power connection point **48** to sensor/transducer unit **44** and signal conversion/conditioning unit **46**.

Data may be further arranged to transfer with a corresponding flow. Data from signal conversion/conditioning unit **46**, for example, may flow through dock/connector **64** and to software service **60** through the same line that carries data from signal conversion/conditioning unit **56**. The line for data transfer for signal conversion/conditioning units **46**, **56** passes through line connector **66**, which may provide an interchangeable coupling—other WEMs or other WEAs may be connected to software service **60** via the same connection.

As stated above, a WEA may also be arranged to include a base device (e.g. a device including a processor) and one or more WEMs (base device+WEMs). Reference is now made to FIG. **3**, which illustrates workflow-enhancing appliance (WEA) **70**, having base device **72** and WEM **82**, in accordance with an embodiment of the invention.

In FIG. **3**, Base device **72** may be any computer device (a device including a computer processor), such as a PC, laptop, notebook, tablet, netbook or mini-computer, a personal digital assistant (PDA), a cell phone, a smartphone, a MP3 player or other consumer computer device. Base device **72** may include processor **74** coupled to memory **75** and power source **76**. WEM **82** may be interchangeably coupled to base device **72** through dock/connector **80**. Dock/connector **80** may be Peripheral Component Interconnect (PCI)-based interface or serial equivalent. WEM **82** may be removed from dock/connector **80** and other WEMs may be coupled using the same connection.

WEM **82**, like WEMs **12**, **42** and **52** (see FIGS. **1**, **2**A and **2**B), may provide a task functionality that can be incorporated into a workflow. In FIG. **3**, WEM **82** may be configured to authenticate printed material, such as printed material on a label or printed material on a document or other item, (e.g. deed, stock certificate, bill of currency or an artistic print). In such an example, item **88** may be printed material, and sensor/transducer **84** may include, for example, a 2D scanner or sensor/transducer **84** may include a wide field-of-view digital microscope device (described also above), which provides forensic image analysis capability.

A transducer within sensor/transducer **84** may receive a signal input from the sensor (e.g. the 2D scanner or digital microscope) concerning input read (or measured) by the sensor and may output an electric signal (e.g. either analog or digital). Signal conversion/conditioning unit **86** may receive the electric signal (condition and/or convert the electric signal (e.g. to a digital signal) and provide digital output to processor **74** of base device **72** through dock/connector **80**. Processor **74**, may process the received digital output using software service **78**.

Software service **78**, in this example, may be programming that allows processor **74** to interface with electronic workflow system **89**. Processor **74** may receives data from signal conversion/conditioning unit **86** and may format or otherwise process the data, using software service **78** programming for example, to create usable metadata for electronic workflow system **89**. In such an example the metadata created may be unique item-level data for item **88**.

The connection between base device **72** (e.g. processor **74**) and electronic workflow system **89**, may be a physical connection, e.g. through a wire (such as through a T-carrier (e.g. T1), local area network (LAN) or other line based connection) or the connection between base device **72** (e.g. processor **74**) and electronic workflow system **30** may be through a wireless connection (e.g. Wi-Fi). Any kind of known communication medium may be used.

Power for sensor **84**, transducer **85** and signal conversion/conditioning unit **86** may be provided by power source **76** within base device **72**. Power may flow from power source **78** to sensor **84**, transducer **85** and signal conversion/conditioning unit **86** through dock/connector **80**.

As described above, a workflow-enhancing appliance (WEA) may be further incorporated into printing environment, for example, to add workflow capabilities and control to printing-related tasks. A multifunction printer (MFP) with one or more WEMs may be operated in an office or other environment as a "workflow kiosk." Routers, PC workstations and other computer devices may also be set up as workflow kiosks in offices and other environments.

Reference is now made to FIG. **4**A, which illustrates a workflow kiosk, having a single WEM coupled to a multifunction printer (MFP), in accordance with an embodiment of the invention.

FIG. **4**A depicts WEM **91**, which may provide a task functionality that can be incorporated into a workflow. In this example, WEA **90** includes only WEM **91**. WEM **91** may be configured to authenticate printed material (e.g. deed, stock certificate, bill of currency or an artistic print). In such an example, item **94** may be printed material, and sensor/transducer unit **92** may include, for example, a 2D scanner or a wide field-of-view digital microscope device (which may provide forensic image analysis capability).

In FIG. **4**A, WEM **91** may interface with multifunction printer (MFP) **95** to transfer data. Within sensor/transducer unit **92**, a transducer may receive a signal from a sensor (e.g. a wide field-of-view digital microscope), and may generate an electric signal (e.g. an analog signal or a digital signal). Sensor/transducer unit **92** may provide that electric signal to signal conversion/conditioning unit **93**. Signal conversion/conditioning unit **93** may condition and/or convert the signal and may provide digital output to processor **97** in MFP **95**. Processor **97**, may process the received digital output using software service **96**. WEM **91** may be interchangeably coupled to processor **97**, through connection **99** (e.g. which may be part of or external to WEA **90** and may be either a wireless or wire connection). WEM **91** may be exchanged through connection **99** with other modular WEMs.

Software service **96**, in this example, may be programming that allows processor **97** to generate metadata from the received signal conversion/conditioning unit output (e.g. from **93**) and interface with electronic workflow system **98**. Software service **96** may be programming stored in a memory (not shown) of MFP **95**. Processor **97** using software service **96**, may forward the generated metadata to electronic workflow system **98**.

In addition to the above it is also possible that a number of multifunctional printer-type workflow kiosks (or other computer devices connected to WEAs) may be controlled by a centralized-control server in a network.

Reference is now made to FIG. **4**B, which illustrates a network configuration for centralized control of MFPs **95**, **103** serving as workflow kiosks. From FIG. **4**A, MFP **95** and WEA **90** are depicted. WEA **90** includes WEM **91** having sensor/transducer unit **92** and signal conversion/conditioning unit **93**, as in FIG. **4**A. Also, WEM **91** is interchangeably coupled to MFP **95** (and processor **97**) via connector **99** as in FIG. **4**A. WEM **91** gathers information (through sensor/transducer unit **92**) concerning item **94** and transmits that information (through signal conversion/conditioning unit **93** to processor **97**.

In the configuration of FIG. **4**B, however, processor **97** may communicate with, receive instructions from or be controlled by processor **101**, which may be located on centralized-control server **100**. In such a configuration, processor **101** of centralized-control server **100** may be connected to many different multi-function printers (MFPs) in a network, such as MFP **95** and MFP **103**. MFP **103** may include a processor **102** and may be connected to its own WEA **104** (e.g. through connection **109**, a wireless or wire connection). WEA **104** may include WEM **105**, such as a module for authentication or card reading. WEM **105**, like WEM **91**, may include a sensor/transducer unit (e.g. **106**) and a signal conversion/conditioning unit (e.g. **107**). Item **108** may be a label or other document to be authenticated, for example.

Software service **96*a*** (on centralized-control server **100**) may provide a service for controlling different WEMs, e.g., **91**, **105** that may be coupled to the MFPs in the network. Processor **101**, e.g. using software service **96*a***, may discover devices (e.g. WEMs **91**, **105**) that have been coupled to the MFPs in the network (e.g. **95**, **103**). Processor **101** may receive in this example a command from electronic workflow system **98** to perform a task, such as to validate a particular document at a particular MFP (e.g. **103**, using WEM **105**).

Processor **101**, e.g. operating software service **96*a***, may map (or translate) the received workflow command into a sequence of data collection tasks, where the task may be performed by WEM **105**. Processor **101** may load on to processor **102** (at MFP **103**) the processing steps for use of WEM **105**. Processor **102** may then activate WEM **105** and control the operation of WEM **105** using the control elements downloaded from the centralized-control server **100**. Processor **102** may transmit data to processor **101** (at the centralized-control server **100**) for re-transmission to electronic workflow system **98** or, alternatively, processor **102** may transmit the data directly to electronic workflow system **98**.

Reference is now made to FIG. **5**, which illustrates a workflow kiosk, having one WEM incorporated into a MFP and a second WEM interchangeably coupled to the MFP, in accordance with an embodiment of the invention. FIG. **5** depicts WEM **112** interchangeably coupled to MFP **120** (e.g. through connector **133**). MFP **120** may further include WEM **122**. WEA **110**, in this example, includes WEMs **112**, **122** and MFP **120** (following the example of a base device (in this case MFP **120**) coupled to WEMs (**112** and **122**)).

WEM **122** may be configured to authenticate printed material (e.g. deed, stock certificate, bill of currency or an artistic print). However, in this example, the authorization capability may be incorporated into MFP **120** through WEM **122**. In such an example, item **128** may be printed material that comes to MFP **120** (e.g. though a submitted print job), and sensor/transducer unit **124** (of WEM **122**) may include, for example, a 2D scanner or sensor/transducer unit **124** may be a wide field-of-view digital microscope device (described also above), which provides forensic image analysis capability.

WEM **122** may interface with processor **132** of MFP **120** to perform a data transfer. Signal conversion/conditioning unit **126** may receive an electric signal (e.g. an analog signal) from sensor/transducer unit **124** and may provide digital output to processor **132**. Processor **132**, may process the received digital output using software service **130**.

WEM **112** may be interchangeable coupled (or tethered) to MFP **120** (e.g. it is not integral to MFP **120**). Alternatively, WEM **112** could be tethered without coupler **133** and the tethering (or a connection to MFP **120** and processor **132**) may be achieved by a wire connection or a wireless connection. WEM **112** may provide additional task functionality for workflows. WEM **112** may provide, for example, user identification functionality. Item **118** may be a body part of a person. For this example, sensor/transducer unit **114** may include hardware for providing user identification validation, such as a fingerprint scanner, retinal scanner, voice processing hardware or inertial sensing hardware. (In another example, item **118** may be a card or ID badge carried by a person and sensor/transducer unit **114** may include a reader, such as a magnetic strip reader or Smart card reader.)

Signal conversion/conditioning unit **116** may receive an electric signal (e.g. analog or digital signal) from sensor/transducer unit **114** and may provide digital output to processor **132** in MFP **120**. Processor **132**, may process the received digital output using software service **130** and output metadata to electronic workflow system **134**.

Software service **130** may be programming that allows processor **132** to create metadata from the received signal conversion/conditioning unit output (e.g. outputs from units **116**, **126**) and transfer the metadata to electronic workflow system **134**. In such an example the metadata created may be unique item-level data for items **118**, **128**, respectively. Processor **132** using software service **130** may process the received signal conversion/conditioning unit data, generate metadata and forward the metadata to electronic workflow system **134**.

Reference is now made to FIG. **6**, which illustrates a workflow kiosk, having WEM **162** incorporated into MFP **150** and multiple WEMs (**142**, **152**) coupled to MFP **150**, in accordance with an embodiment of the invention. WEA **140** in this example includes WEMs **142**, **152**, **162** and MFP **150**.

WEM **142** may be interchangeably coupled (or tethered) to MFP **150** (e.g. through connection **171**, which may be either a physical connector or a wireless connection) and may provide task functionality such as user identification functionality. The coupling may be through a line connection between WEM **142** and MFP **150** or WEM **142** and MFP **150** may communicate through a wireless connection. Item **148**, in this example (for user identification functionality), may be a body part of a person.

Sensor/transducer unit **144** may include hardware for providing user identification validation, such as a fingerprint scanner, retinal scanner, voice processing hardware or inertial sensing hardware. (In another example, item **148** may be a card or ID badge carried by a person and sensor/transducer unit **144** may include a magnetic strip or Smart card reader device). Signal conversion/conditioning unit **146** may receive an electric signal from sensor/transducer unit **144** and may provide digital output to processor **170** in MFP **150**.

WEM **142** may be further coupled to WEM **152**. WEM **152** may further include sensor/transducer unit **154** and signal conversion/conditioning unit **156**. WEM **142** may be coupled to WEM **152** by dock/connector **160**. Dock/connector **160** may be, for example, a multi-way connector. WEM **152** may provide functionality for a task that can be incorporated into a workflow, such as biometric handwriting analysis (e.g. for validating a signature), fingerprint identification or iris scanning.

Sensor/transducer unit **154** may include hardware that measures physical quantity or aspect of item **158**. For example, Sensor/transducer unit **154** may measure the inertial movements of a hand as it makes a signature (or the surface of a finger or an iris). Sensor/transducer unit **154** may convert the measurements into electric signal. Signal conversion/conditioning unit **156** may receive input (e.g. an analog signal) from sensor/transducer unit **154** and may provide digital output to processor **170** for processing using software service **172**. In FIG. **6**, signal conversion/conditioning unit **156** may output the digital output through dock/connector **160**. Data from signal conversion/conditioning unit **156** may flow through dock/connector **160** to the same line (or wireless connection) that carries data to processor **170** from signal conversion/conditioning unit **146**.

In MFP **150**, WEM **162** may authenticate printed material (e.g. deed, stock certificate, bill of currency or an artistic print). Sensor/transducer unit **164** (of WEM **162**) may include, for example, a 2D scanner or sensor/transducer unit **164** may be a wide field-of-view digital microscope device. WEM **162** may interface with processor **170** to perform a data transfer. Signal conversion/conditioning unit **166** may receive analog input from sensor/transducer unit **164** and may provide digital output to processor **170**. Processor **170**, may process the received digital output using software service **172**. Software service **172** may be stored in a memory (not shown) of MFP **150**.

Software service **172** may allow processor **170** to create metadata from the received signal conversion/conditioning unit output (e.g. from signal conversion/conditioning units **146**, **156**, **166**) and interface with electronic workflow system **174**. In such an example, the metadata created may be unique item-level data for items **148**, **158**, **168**. Processor **170** using software service **172** may forward the generated metadata to electronic workflow system **174**.

In the examples provided in FIGS. **1**, **2**A-B, **3**, **4**A-B and **5**-**6**, WEMs may be deployed for customized functionality using one or more of the following procedures:

Manual Deoloyment:

(e.g. plug-in of individual WEMs): Manual deployment may be useful for the WEA as a mobile (handheld) appliance, and may further be useful when a WEM is coupled to a base device, like a computer, laptop or smartphone device. A dock for a WEM plug-in may be device docks currently common for peripherals that may attach to devices such as GPS systems, radio-frequency identification (RFID) systems, digital camera systems, etc. Where a WEA is coupled through a dock to a base device, the base device may also provide authorization to activate associated workflow services, either through permissions maintained on the base device or through permissions transmitted from an electronic workflow system.

Docking-Based Deployment:

Dock-based deployment may be useful when one or more of WEMs are incorporated into or make up a tethered appliance attached to another appliance, such as an MFP. WEMs that are tethered, in such an example, can be stored or "docked" in the MFP. As WEMs are docked in the MFP, different modules can be changed out from the tether so WEMs needed for particular workflow tasks can be selected from the dock, with the unnecessary modules being retained in the docking device. The tethered device, in an embodiment, may be pull-out appliance (a base device) from an MFP to which WEMs attach. When the tethered device is not in use, the base device and the WEMs dock in a small place under a control panel, for example, in the MFP.

Functional/Security Applicability-Activated Deployment:

In such a configuration a WEA may be a stand-alone device that incorporates (or may have as plug-ins) many or all of the WEMs for all the workflows it enables, but none of the WEM may work/gather data until an appropriate authorization is provided.

The functionality required for the workflow may dictate the activation or deployment techniques used for the set of appropriate WEMs.

Multiple Appliances/Item-Level Data in Workflows

Reference is now made to FIG. **7**, which illustrates a prior art retail workflow system. In FIG. **7**, a retail stock control system **182** collects data for the retailer, for example, in a manner where non-item-level identifiers are used to update inventory stock levels and order data as items pass through a "goods-in" point **184** (e.g. a location where delivery is taken for a quantity of goods) and a point of sale (POS) point **186**. Such a system of capturing data using non-item-level identifiers can be related to "just-in-time" (JIT) ordering and, also in relation, to JIT distribution, JIT manufacturing, JIT raw materials ordering and other JIT data collection processes. Therefore, the complete system works on non-item-level data.

In such an example, items may be scanned either at goods-in point **184** or POS point **186** and the inventory for the retailer may be updated. For example, non-item-level stock counts such as 100 shirts (of style "xxx") and 200 pants (of style "yyy") may be listed as the current inventory. Further, non-item-level information may be obtained at POS point **186**, when customer **188** makes a purchase. If one shirt is sold, for example, the stock level count for shirts in the retail stock control system goes from 100 to 99. No further information is provided from customer **188** after purchase. All information may be stored in retail control system **158**.

Reference is now made to FIG. **8**, which illustrates a retail workflow system workflow-enhancing appliances (WEAs) capture item-level data and interface with an electronic workflow system, in accordance with an embodiment of the invention. In this example a retailer may be a pharmacy. An item being inventoried, ordered and sold (and hence tracked in a workflow) may be, for example a prescription-only cardiac medication **202**.

FIG. **8** depicts WEAs **210**, **220**, **230**, where each may be used for different tasks in the movement of cardiac medication **202**. For example, WEA **210** may be used at the point of "goods-in" (e.g. by employee **218**), where cardiac medication **202** may be received by the retailer. WEA **210** may include WEMs **212** and **214**. WEM **212** may be a 2D barcode reader and WEM **214** may be a GPS sensor. FIG. **8** further depicts WEA **220** being used at a point of sale (POS). WEA **220** may include WEM **222** (e.g. a 2D barcode reader) and WEM **224** (e.g. an authentication device).

WEA **230** may be controlled by customer/patient **238**. In FIG. **8**, WEA **230** may include WEMs **232** and **234**. WEM **232** may be a 2D barcode reader and WEM **234** may be an electrocardiogram (ECG) monitor.

WEAs **210**, **220**, **230** may be used to perform tasks and interface with electronic workflow system **240**. Electronic workflow system **240** may be a computer-based system (in this example computing systems within an Internet computing cloud) for tracking, monitoring or authorizing product movement or product events. Electronic workflow system **240** may include a relational database management system or similar computer system (e.g. within the computing cloud) to store data concerning product movement and events.

Each WEA **210**, **220**, **230** may communicate with electronic workflow system **240** using software services **216**, **226**, **236**, respectively. WEA **210**, **220**, **230** may each further include a processor (not shown) to, for example operate software services **216**, **226**, **236**, respectively, and WEMs (**212**, **214**, **222**, **224**, **232**, **234**) that may be part of WEA **210**, **220**, **230**, respectively. (Alternatively, software services **216**, **226**, **236** may be incorporated into electronic workflow system **240**, where WEAs **210**, **220**, **230** include communication facilities).

In the example of FIG. **8**, cardiac medication stock (medication, item) **202** may be received at the goods-in location by employee **218**. There, WEA **210** may be used to read barcode **204**, which may be on the packaging of medication **202**. In such an example, employee **218** may use WEM **212** to read barcode **204**. A device ID of WEA **210** may be transmitted by software service **216** to access electronic records in electronic workflow system **240**. From such access, item **202** (the container of medicine) may be "checked in."

Data for item **202** may be stored in electronic workflow system **240** and GPS data (as well as date and/or time information) may be added to the electronic records maintained for item **202**. In registering (or checking in) item **202** (the container of medicine), a small printer/scanner such as an HP sp400™ (wrist-worn all-in-one printer) by Hewlett-Packard Company, for example, may be used as WEA **210** and may incorporate WEM **212** for performing scanning tasks.

Referring again to FIG. **8**, customer/patient **238** may require medication and he or she may come to an establishment of the retailer with a prescription. In this example, a person, such as a salesperson or pharmacist (e.g. POS operator **228**), may use WEA **220** with WEMs **222** and **224** installed. POS operator **228**, for example may scan barcode **204**, using WEM **222** (the 2D barcode reader). WEA **220** may then interface with electronic workflow **240** using software service **226**. Records in electronic workflow **240** may be accessed to update stock levels and check for circumstances: 1) that may be associated with this kind of cardiac medication in general (e.g. looking at non-item-level data); or 2) that may be associated with package **202** in particular (e.g. looking at item-level data).

In this example, electronic workflow system **240** may transmit to WEA **220** a notification stating, for example, that due to the strong/high-potency nature of the medication, authentication of the medication is required before it is given to customer/patient **238**. In such an example, POS operator **228** may use WEM **224** (the authentication device) to verify the authenticity of the medication **202** (e.g. through Raman or other optical imaging techniques capable of performing a "mass spectroscopy" analysis of ingredients). Where a Raman or other such imaging device is incorporated into WEM **224** as the authentication device, WEM **224** may be used to forensically analyze the material of the medicine itself.

Alternatively, WEM **224** may, be a wide field-of-view digital microscope device system, which may be used to forensically identify a mark on the surface of a pill or tablet, or a medical document, label, prescription, etc. This type of authentication using forensic marking would be different than the "mass spectroscopy"-type authentication described in the previous paragraph. WEA **220** (a mobile device) incorporating a wide field-of-view digital microscope also may be used to take a forensic image of a security fiducial (e.g. one or more printed characters/marks (which may be used in a workflow item (e.g. a document) for a particular workflow security need). For example, the security fiducial may be located next to barcode **204**. This image derived data may be checked against the original electronic record as well as, for example, chain of custody information or prescription information (such as for verifying the medicine against a "tamper-resistant" (source-verifiable) prescription. If the information matches, customer/patient **238** may receive the medicine.

Following such a sale, customer/patient **238** may take package **202** (the medication) home. Customer/patient **238** may further ingest a dose of the medicine. Because this may be the first time customer/patient **238** has been prescribed this medication, he or she may be required perform a monitoring procedure, such as electrocardiogram (ECG) monitoring, after taking each dose. In such an example, customer/patient **238** may use WEA **230** (which may be a camera enabled smartphone) to capture the 2D barcode (e.g. using WEM **232**) and access electronic records from electronic workflow system **240** concerning the medication (e.g. using software service **236**). Customer/patient **238** may perform this access using a mobile application, such as one that may be available from organizations such as ScanBuy, Open Mobile Alliance (OMA) or GSI Commerce, or a custom application. In such an example, where access is attempted using a 2D barcode alone, additional authorization may be required to meet negotiated, for example, Health Insurance Portability and Accountability Act (HIPAA) etc. regulations for the application.

In FIG. **8**, customer/patient **238** may receive from electronic workflow system **240** an instruction to perform ECG monitoring (using WEM **234**) after taking the medication. Customer/patient **238** may administer the ECG (using WEM **234**), and data may processed (filtered etc.) either locally (e.g. by software service **236**) or by a remote service (e.g. within the Internet computing cloud). The results may be compared to patient's records and limits maintained in electronic workflow system **240**. Depending on the result, Customer/patient **238** may be sent either an all clear notification, or, alternatively, a notification not to take any more medication and see consultant.

A further use of a WEA may be seen, when the example of FIG. **8** is modified by a situation where particular counterfeit drugs have been detected within the drug distribution system. In such a situation, there may be a system-wide alert, within electronic workflow system **240** that counterfeit drugs may have been detected. If an alert has been sounded, WEA **210** (e.g. the mobile device at the "goods-in" point of the retailer) may receive a notification (or an alert) from electronic workflow system **240** that additional WEM **219** (a forensic authentication module) is required for "checking in" a certain suspect delivery.

In such a situation, user **218** (the operator at the goods-in location) may then add WEM **219** to WEA **210** (e.g. couple WEM **219** to WEA **210** as a plug-in module) and perform the forensic check, accessing and updating records in electronic workflow system **240** (e.g. using software service **216**).

Reference is now made to FIG. **9**, which illustrates a prior art network printing system. In FIG. **9**, network **310** provides communication links and connections for two personal computers, PC **315** (PC **1**) and PC **320** (PC **2**). Each of the PCs **315**, **320** may access either one of multifunction printers **325**, **330** (MFP **1** and MFP **2**) using network **310**. The PCs **315**, **320** may access the printers, but no workflow metadata or workflow interface is created in this prior art example.

Reference is now made to FIG. **10**, which illustrates a network printing system using workflow-enhancing appliances, in accordance with an embodiment of the invention. FIG. **10** depicts network **350**, with connections to PC **360** (PC **1**), PC **365** (PC **2**), multifunctional printer (MFP) **370** (MFP **1**) and MFP **375** (MFP **2**). In this example, network **350** is further connected to electronic workflow system **352**. Electronic workflow system **352** may be a computer-based system (such as a group of computing systems including a relational database management system) for tracking, monitoring or authorizing movement or events concerning a document production workflow. Electronic workflow system **352** may include data such as electronic records, document policy information and security information.

PC **360** may be configured with WEMs **362**, **364**. WEM **362** may be a 2D barcode reader and WEM **364** may be a document authentication device. MFP **370** may be configured with WEMs **372**, **374**. WEM **372** may be a user identification device and WEM **374** may be a document authentication device. Additionally, MFP **380** is configured with WEM **382**. In this example, WEM **382** may be a document authentication device.

FIG. **10** provides an example of a document-based workflow, where MFPs **370**, **380** (configured as WEAs and operating as workflow kiosks) and PC **360** (as also configured as a WEA and operating as a workflow kiosk) work together in the handling of a document through a workflow. In this example, a document, such as a legal property deed, may be created and a workflow concerning that document may ensue. Employee **392** may use PC **360** to print one copy of the deed on MFP **370** (MFP **1**). MFP **370** may process the printing request, and employee **392** may move to MFP **370** to collect the document. Security may be controlled by electronic workflow system **352**. At MFP **370**, electronic workflow **352** may enforce a requirement that employee **392** may collect the document only after he or she enters identification. In such an example, WEM **372**, a user identification device, may be activated. WEM **372** may be, for example, a fingerprint reader or other user forensic identification device.

Additionally, as the document is being printed by MFP **370** an authentication mark may be scanned during the printing by WEM **374**. In such an example, WEM **374** may be an authentication device such as a wide field-of-view digital microscope device for forensic authentication. Such an authentication task may be required from previous state in the workflow, or the need for an authorization may have resulted from an event in the current state of the workflow. The use of a forensic mark, or the need for one (and the specification of what to use as one) may be defined on the fly, just as the document is being printed, for example, because of a change in the overall workflow; i.e. a reactive change.

In this process, unique data may be collected and registered to the document ID through a transmission to electronic workflow system **352**. The transmission may occur via network **350** using, for example, software service **376**.

In FIG. **10**, employee **392**, after collecting the document may proofread it and then may register the proofreading action by scanning the authentication mark on the document using WEM **364** at PC **360** (PC **1**). PC **360** may have been configured with WEM **364** (an authorization device), which may be used at PC **360** to register the action. Data may be collected by WEM **364** and then transferred using software service **366** to electronic workflow system **352** (via network **350**). Employee **392** may then send the document to customer **394**.

Customer **394** may validate the document using MFP **380** (MFP **3**) configured with a WEM (e.g. **382**) that is an authorization module. (Another WEA, such as a PC coupled to a WEM that is an authorization module may also be used.) The authentication process of WEM **382**, in this example, may send details of the content of the document to electronic workflow system **352** (e.g. using software service **386**) and software service **386** may compare the gathered information against data saved in **352** to as a check against document tampering or other forms of fraud, such as copying, high-res replication, substitution, etc.

Layered Software Platform

An embodiment of the invention may further provide a layered software platform (infrastructure) for operation of a WEM. For example, a layered software platform may be provided in WEAs such as a multifunction printer or computer workstation configured as a WEA or a, PDA, cell phone, smartphone, barcode reader or other computer device configured as a WEA. A WEM that is a stand-alone device may also include a layered software platform for operation. Further, a layered architecture may be used in a network configuration, where, for example, many workflow kiosks are controlled or interface with a centralized control server (e.g. by a managed service).

For a WEA such as a multifunction printer (or for a server controlling a number of workflow kiosks), a layered architecture may be provided through an extension to a platform such as the "Open Extensibility Platform" (OXP) of the Hewlett-Packard Company of Palo Alto, Calif. The OXP platform may include three main layers covering, for example: 1) device, 2) management and 3) workflow.

Reference is now made to FIG. **11**, which illustrates software platform layers which may be suitable for operation of WEMs through devices such as a multifunction printer. FIG. **11** shows layered architecture **405**, including workflow layer **410**, management layer **420** and device infrastructure layer **430**.

Workflow layer **410** may provide job submission, routing, tracking, data archive and document transformation services. Such a layer may operate by defining a job and a document. Workflow layer **410** may translate extant and nascent workflow requirements into tasks that require hardware associated with a kiosk/base device. For example, when a device (WEM) is added to a kiosk, the device's capabilities are automatically added by matching the device specs to defined WEM software module(s) **435** that are, for example, located in device infrastructure layer **430**. Device infrastructure layer **430** may provide marking, digital sending, copying, document finishing and I/O services. Device infrastructure layer **430** may interact with the user, for example, in converting documents to and from paper. Management layer **420** may provide fleet and solution management and configuration services (e.g. services to manage multiple printers or workstations). Management layer **420**, for example, may discover devices, track pages processed and kiosk usage.

Within a managed service using a network configuration (where the layered architecture is operated from a centralized control server, see e.g. FIG. **4**B), only certain devices (e.g. certain printers in a network) may have certain WEM software module(s) **435** enabled through the presence of WEAs. In implementation, such a configuration may be conceptually no different from searching on a network for a machine (printer) that has stapling, 2-sided printing, legal-sized paper, etc. The set of kiosks or MFP/all-in-one/printing etc devices in a network may be managed together through management layer **420**, as part of a managed service.

WEM software module(s) **435** in a network configuration using a centralized control server may be centrally maintained, and not separately stored on each kiosk device. In such an example, each kiosk in a network may search for all of the WEM software modules **435** corresponding to all the WEMs that can be accommodated by WEAs on the particular kiosk, and so (dynamically) each kiosk, in a centrally managed system may offer the latest, fullest set of WEAs possible. (However, in a different example, each kiosk can host the WEM software modules, and in such a system may require further upkeep of the software). WEM functionality may be written akin to how applications (or "apps" for devices, such as mobile devices (e.g. iPhone™), WebOS, etc. are written, for example, taking into account the sensors that are available, writing new apps involving at least one of the available sensors.

One use for a device (such as a MFP) operating with a layered architecture (e.g. through a centrally-maintained WEM-software service) may be to associate metadata with a scanned document being sent to a workflow. Using a layered architecture, such as that depicted in FIG. **11** (e.g. an extension of an operating system such as the OXP™ system), an application may discover the devices to be configured (e.g. the WEMs that are coupled to the MFP or other base device) and then configure the devices to associate, for example, a button on the front of the device with a Web-services call.

Reference is now made to FIG. **12**, which illustrates a set of buttons which may be included in a device such as a MFP. FIG. **12** depicts reimbursement account button **440**, copy button **445**, network folder transmission button **450** and e-mail button **445**.

In such an example, when a user touches a button, such as for example reimbursement account button **440**, a dialog box may appear (e.g. when enabled for a Web-services call) to retrieve an account number, such as a number for a bank account, a retirement/401(k) account, a credit balance, an order account, an active case account, a customer list, etc.

After the user enters the account number, a procedure such as a "scan-to-PDF" procedure may occur (e.g. where a document is scanned and a Portable Document Format (PDF) file is created) and a transfer may occur where the generated PDF file is transferred to a specified location (for example to a location in an electronic workflow system).

Many different information transfers and authorizations may occur using a device such as a multifunction printer (MFP) configured using a layered architecture that incorporates a modular WEM system. With such a system of dynamically changeable WEMs developers may produce a wide variety of applications pertaining to workflow use. Because, in general, a WEA may be used to add information to the workflow, many different information transfers may occur for example using a MFP configured with a flexible, layered architecture. Example applications include forensic/security, biometric, environmental (GPS, temp, humidity) and informational (e.g. WiFi-ing more data, synching calendar, product status, etc., data to a printout location-incorporating into a barcode, etc.) types.

Additionally, a layered software platform may allow for the operation of WEMs in configurations, where, for example, a WEM may be coupled to a mobile base device, a computer workstation (e.g. other than an MFP using an OXP operating system) or where a WEM is incorporated into a stand alone device. Reference is now made to FIG. **13**, which is an illustration showing layered architecture **456** for a processor of a base device (such as a computer, PDA, cell phone, smartphone, barcode reader) or a stand-alone device of a WEA.

In FIG. **13**, task to workflow mapping layer **460** may be a top (highest or most abstract) layer. Task to workflow mapping layer **460** may translate workflow commands (e.g. commands received by an electronic workflow system for a task) into a set and sequence of WEM-related commands needed for the task. In such an example, task to workflow mapping layer **460** may take a set of instructions for a task and map them to a sequence of WEM operations needed to accomplish them.

Workflow governance layer **465** may translate the sequence of WEM operations into a corresponding set of data collection tasks. Such data collection tasks may include data transduction, sampling, filtering, processing and analytics. Sub-layer **470** may provide analytic processing for task specific data and information conversion. Sub-layer **475** may provide data processing for image and sensor data. Sub-layer **480** may provide processing for signals, such as transduction, sampling and filtering of signals.

Messaging layer **485** may provide programming to load the processing task execution instructions (such as instructions for the data collection tasks) onto the processor controlling the sensor, transducer, and signal conversion/signal conditioning unit of the WEM. Because WEMs may provide services, the WEM software module(s) may map specific workflow tasks to hardware tasks that need occur. As shown in FIG. **13**, the WEM software module(s) **495** include but are not limited to the software to capture input from the wide field-of-view digital microscope, etc. devices.

FIG. **13** shows workflow program memory layer **490** and a layer also of WEM software module(s) **495**. WEM control modules (in layer **495**) may provide instructions to drive the WEM devices. FIG. **13** shows WEM software **500** (to control a wide field-of-view digital microscope device), WEM software **505** (to control a GPS device), WEM software **510** (to control an E-field device, which may be used to gather biometric data such as ECG signals) and WEM software **515** (to control an inertial sensor, e.g. for gathering biometric information). Other WEM software module(s) **495** for other workflow functions are also possible.

If applicable, one or more base device layers (e.g. layers **520** and **525**) may be further provided in the layered architecture. For example, FIG. **13** shows layer **520** for base device or WEA add-on slot hardware interfaces. Layer **520** may also provide a radio (RF) interface for wireless communications. Layer **525** may provide programming for base device functionality (e.g. outer shell, slots, and baseline functionality), power and other functionality for wireless or tethered applications (e.g. using a battery if non-tethered is an option), memory use functionality and processing functionality (e.g. including programming for additional WEA add-on slots).

Applicability of base device layers **520** and **525** may be determined on factors, such as ergonomics (ease of use), security, reliability, cost, exchangeability, sustainability/power usage, etc. A further layer for associating of WEM-gathered data with the overall workflow (e.g. an electronic workflow system) is provided at layer **530**.

For portable WEAs, the optimal device configuration may be a function of, for example, user preference, history, compliance and/or policy needs. A single portable WEA may be crafted for a particular task—such as track and trace-based on a layered architecture, and that device may be configured with WEMs to perform different tasks which may be included in a workflow. Examples of simple retail tasks in the workflow include:

Track and trace (product tracking);

Interrogate (e.g. barcode scan) a product with a device an get a coupon;

Download product information (such as ingredients or parts);

Download product provenance (e.g. to determine if the product would cause an allergic reaction peanut allergy);

Point of Sale (tracking product sales on an item-level);

Inspection (assessing damage to products on an item-level);

Authentication/counterfeit detection;

Target users, in this example, run the gamut from consumer, retailer, distributor, inspector, manufacturer to forensic agents. The same WEA can be customized for use by different actors at each node (or point) in the supply chain/workflow.

Process Flows

Reference is now made to FIG. **14**, which is an exemplary process flow diagram for gathering data in an electronic workflow system using a system of sensing modules such as WEMs.

The process may being at step **542**, and in step **544** the system may provide a plurality of sensing modules (such as WEMs) for sensing information concerning work-flow related tasks (e.g. tasks monitored and/or controlled by an electronic workflow system). In step **546** a processor, such as one operating a software service, may receive an indication that one module from plurality of modules has been connected to a processor device (e.g. a multifunction printer, base device or other processor device) for performing a task-related to the workflow. For example a WEM for performing 2D barcode scanning or a WEM for performing document authorization using a wide field-of-view digital microscope device may be connected.

In step **548** the processor, such as the processor operating a software service, may configure software within the software service to operate the selected module (the selected WEM) by loading control software that corresponds to the one module being connected. As shown in FIG. **13**, layered software architecture **456** may contain a layer (e.g. layer **495**), for loading modules such as WEM software **500** for operating devices such as a wide field-of-view digital microscope. Such control software may be loaded upon receipt of a connection command.

In step **550**, the processor may receive data from the one module (the connected WEM) that is performing the task related to the workflow. In such an embodiment, a WEM such as a wide field-of-view digital microscope authorization service may transmit data concerning an authorization process performed on a document. In step **552** the processor, e.g. using routines from of the software service, may create metadata records from the received data that are usable in an electronic workflow system. In step **554**, the processor sends the metadata to the electronic workflow system and in step **556** the process terminates.

Reference is now made to FIG. **15**, which is an exemplary process flow for operating a workflow where an electronic workflow system controls the operation of a WEM.

In FIG. **15**, the process begins in step **562**, and in step **564** a processor, such as one operating a centralized control service for a network of workflow kiosks, may receive a command from an electronic workflow to perform a task. The task may be, for example, to validate a document, to check the provenance of a package, or restrict the access of a document to only users who are authorized to see a document with proper security clearance.

In step **566**, a processor, e.g. operating a centralized-network service, may map (or translate) the received workflow command into a sequence of data collection tasks, where the tasks may be performed, for example, by one or more interchangeably coupleable sensing modules. Such interchangeably coupleable sensing modules may be the WEMs described above, for example with regard to FIGS. **1**, **2**A-B, **3**, **4**A-B and **5**-**6**.

In step **568**, the processor may load on to a WEM processor (e.g. to the processor of the workflow kiosk) processing steps for use by one or more control elements (e.g. WEM software **500**, **505**, **510**, **515** of FIG. **13**), where the one or more control elements correspond to the one or more interchangeably coupleable modules at the kiosk.

In step **570**, the processor at the kiosk activates the selected modules (the one, selected WEM) and controls the operation of the one module using the corresponding control element. In controlling the operation of the one module, the processor at the kiosk may receive data and create, for example, metadata concerning the operation of the module. In step **572**, the processor may transmit data concerning the task (e.g. in the form of metadata created from the data received from the module) to the electronic workflow system. In step **574** the process terminates.

An embodiment of the invention may provide a scalable system that addresses the variable situation dependent requirements of interaction with item-level workflows. A WEA may provide an optimized device configuration based on a workflow need.

As more systems may be developed to tie physical items to electronic records, modular devices that may be focused on diverse physical/electronic world interaction (rather than the current single function model of workflow device) may be useful for workflow tasks. Such devices may increasingly be of value to anyone wishing to customize their electronic/physical world interfaces. Such customization may be based on different preferences for privacy, security, connectedness, medical needs, location, etc.

Additional Considerations

Unless specifically stated otherwise, as apparent from the discussion above, it is appreciated that throughout the specification discussions utilizing terms such as "processing," "computing," "calculating," "determining," or the like, refer to the action and/or processes of a computer or computing system, or similar electronic computing device, for example comprising processors, that manipulate and/or transform data represented as physical, such as electronic, quantities within the computing system's registers and/or memories into other data similarly represented as physical quantities within the computing system's memories, registers or other such information storage, transmission or display devices.

An embodiment of the invention may be implemented, for example, using a non-transitory computer readable medium or article which may store an instruction or a set of instructions that, if executed by a machine having a processor, cause the processor to perform a method and/or operations in accordance with embodiments of the invention. Such a machine having a processor may include, for example, any suitable processing platform, computing platform, computing device, processing device, computing system, processing system, computer, processor, or the like, and may be implemented using any suitable combination of hardware and/or software. The non-transitory computer readable medium or article may include, for example, any suitable type of memory unit, memory device, memory article, memory medium, storage device, storage article, storage medium and/or storage unit, e.g., memory, removable or non-removable media, erasable or non-erasable media, writeable or re-writeable media, digital or analog media, hard disk, floppy disk, COMPACT DISK READ ONLY MEMORY (CD-ROM), COMPACT DISK RECORDABLE (CD-R), COMPACT DISK REWRITEABLE (CDRW), optical disk, magnetic media, various types of DIGITAL VERSATILE DISKS (DVDs), a tape, a cassette, or the like. The instructions may include any suitable type of code, for example, source code, target code, compiled code, interpreted code, executable code, static code, dynamic code, or the like, and may be implemented using any suitable high-level, low-level, object-oriented, visual, compiled and/or interpreted programming languages like C, C++, JAVA, BASIC, PASCAL, FORTRAN, COBOL, assembly language, machine code, or the like.

The above discussion is meant to be illustrative of the principles and various embodiments of the invention. Numerous variations and modifications will become apparent to those skilled in the art once the above disclosure is fully appreciated. It is intended that the following claims be interpreted to embrace all such variations and modifications.

We claim:

1. A system for performing task execution in a workflow, the system comprising:

a processor device;

at least one modular device comprising a digital microscope that is interchangeably coupled to the processor device;

a memory device coupled to the processor device comprising instructions that when executed by the processor device execute a software service;

a network interface; and

an electronic workflow system coupled to the processor device via the network interface,

wherein,

the digital microscope corresponds to at least one particular task of a workflow to authenticate a workflow item using discrepancy detection, and

the software service controls operation of the at least one modular device and generates forensic metadata from task information received by the digital microscope of the at least one modular device for the electronic workflow system,

the digital microscope facilitates the capture of both intentional printing shapes and unintentional printing artifacts caused by a printing process of the printer and interaction with the ink on a substrate of the workflow item to authenticate the workflow item based on the printing of the workflow item itself.

2. The system of claim **1**, wherein the at least one modular device is coupled to a second modular device comprising a sensor device and wherein the at least one and second modular devices transmit data to the software service.

3. The system of claim **1**, wherein the at least one modular device is connected to a multifunction printer through either a line or wireless connection.

4. The system of claim **1**, wherein the digital microscope comprises a catadioptric or dioptric lens.

5. The system of claim **1**, wherein the software service initiates operation of the at least one modular device in response to a reactive workflow command from the electronic workflow system.

6. The system of claim **1**, wherein the software service comprises a layered software architecture.

7. The system of claim **6**, wherein the layered software architecture comprises a program element in a layer to enable the software service to control operation of the at least one modular device.

8. The system of claim 1, wherein the digital microscope is configured to forensically analyze a given mark in the document to provide a biometric response.

9. A method for electronic workflow system operation, comprising:

sensing information concerning one or more workflow-related tasks with a plurality of modular devices which include at least one digital microscope;

receiving an indication through either a line or wireless connection that a first modular device with the digital microscope of the plurality of modular devices has been connected to a processor device for performing an authentication task related to a workflow using discrepancy detection;

receiving forensic data from the first modular device through either the line or wireless connection concerning the authentication task at a software service executing on the processor device; and

creating forensic metadata from the data received from the first modular device for use in an electronic workflow system coupled to the processor via a network connection,

wherein at least one of the plurality of modular devices is connected to a multifunction printer and wherein the digital microscope facilitates the capture of both intentional printing shapes and unintentional printing artifacts caused by a printing process of the printer and interaction with the ink on a substrate of a workflow item to authenticate the workflow item based on the printing of the workflow item itself.

10. The method of claim 9, wherein, each of the plurality of modular devices couples interchangeably with the processor device.

11. The method of claim 9, further comprising coupling a second modular sensing device of the plurality for performing a second task related to a workflow using the same connection to the processor device used by the first modular device.

12. The method of claim 9, wherein the digital microscope is configured to forensically analyze a given mark in the document to provide a biometric response.

13. A non-transitory computer-readable medium having stored thereon instructions which when executed by a processor cause the processor to perform the method of:

receiving a workflow command from an electronic workflow system coupled to the processor via a network connection to perform an authentication task using discrepancy detection;

mapping the received workflow command into a sequence of forensic data collection tasks to be performed using at least one module device comprising a sensing module with a digital microscope connected to the processor through either a line or wireless connection;

controlling the operation of the at least one module device using a corresponding digital microscope control element through either the line, the wireless connection, or the network connection; and

transmitting forensic data using the network connection concerning the task to the electronic workflow system,

wherein the at least one modular device is connected to a multifunction printer and wherein the digital microscope facilitates the capture of both intentional printing shapes and unintentional printing artifacts caused by a printing process of the printer and interaction with the ink on a substrate of a workflow item to authenticate the workflow item based on the printing of the workflow item itself.

14. The non-transitory computer-readable medium of claim 13, wherein said control element is maintained in a centralized-control server in the network to control a plurality of workflow kiosks.

15. The non-transitory computer-readable medium of claim 14, wherein at least one of the at least one module devices is an interchangeably coupleable sensing module and wherein item-level data is received while controlling the operation of the at least one of the interchangeably coupleable sensing module.

16. The non-transitory computer-readable medium of claim 13, wherein the electronic workflow system comprises a plurality of computer systems within a Web-based computing cloud.

17. The non-transitory computer readable medium of claim 13, wherein the digital microscope is configured to forensically analyze a given mark in the document to provide a biometric response.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,176,743 B2
APPLICATION NO. : 13/810697
DATED : November 3, 2015
INVENTOR(S) : Steven J Simske et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the claims,

In column 26, lines 38 approx., in Claim 17, delete “computer readable” and insert --computer- readable--, therefor.

Signed and Sealed this
Fifth Day of April, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office